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ABSTRACT

This guide is designed to help teachers gain a better understanding of how to get a worm vermicomposting system started. It provides reference curricula materials for using worms in the classroom. Chapters include: (1) "Why Worm Vermicomposting;" (2) "Basics of Vermicomposting;" (3) "Worm Facts;" (4) "Classroom Activities;" (5) "Lab Activities;" and (6) "Case Studies on Vermicomposting." Appendices contain a list of educational materials, worm bin plans, names of worm suppliers, and names of worm bin suppliers. (CCM)

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# Worms, Worms, and Even More Worms

## A Vermicomposting Guide for Teachers

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# Worms, Worms, and Even More Worms


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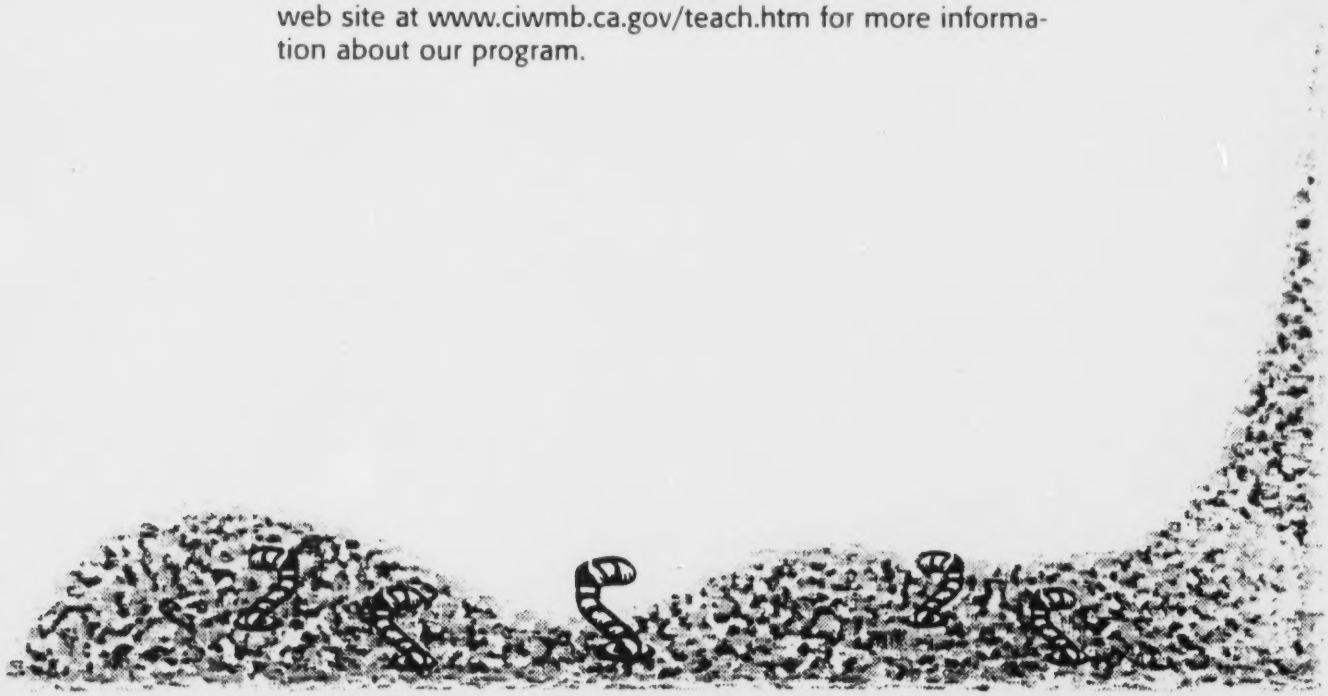
## Networking

The California Integrated Waste Management Board's Public Education and Program Implementation Branch has representatives prepared to assist schools with a variety of issues, including vermicomposting, other school reuse and recycling programs, and a waste management curriculum. Teacher training workshops are available based upon interest and need. If you would like to network with other teachers who are experimenting with vermicomposting or you would like more information on resources available to you in your community, contact the California Integrated Waste Management Board at (916) 255-2385, or write to us at IWMB Public Education and Assistance Program 8800 Cal Center Drive, Sacramento, California, 95826. You can also check our web site at www.ciwmb.ca.gov/teach.htm for more information about our program.



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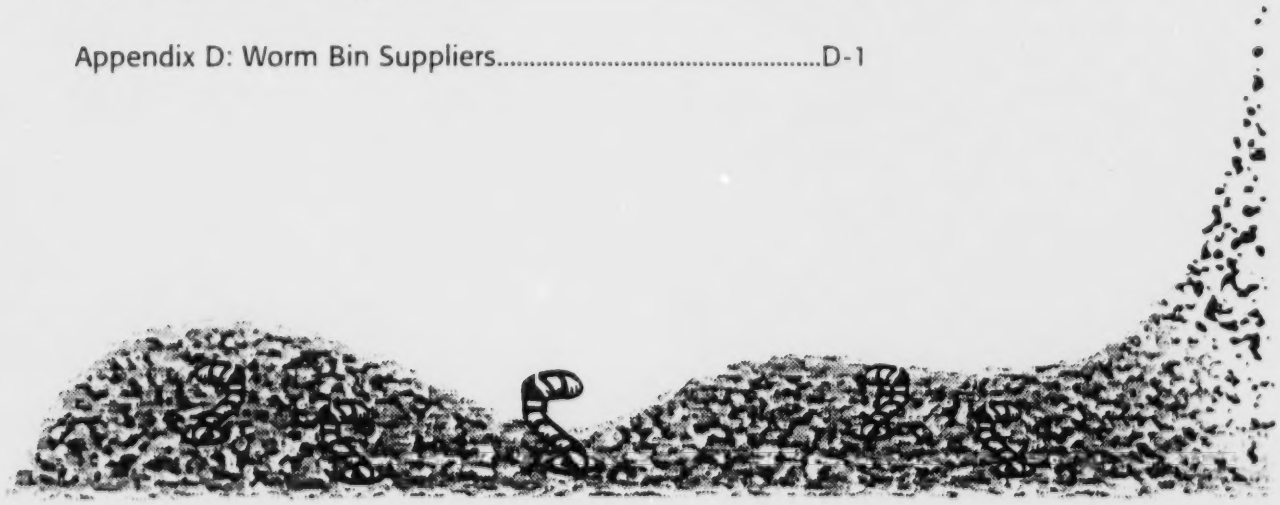


# Why Vermicompost?

What do worms, food waste, and landfills have in common? They are all part of the reason that people vermicompost.

Vermicomposting is the practice of using worms to transform food waste into a nutrient-rich finished product called vermicompost. Worms are efficient food waste digesting machines that eat over half their body weight in organic matter per day. The castings that they create are rich in nutrients, completely natural, and free!

Most people are becoming aware that landfilling garbage is an option that is less and less desirable. While most people think about paper, plastic, and yard trimmings when they think about garbage, food waste can be a significant percentage of the total waste stream. In fact, for schools and institutions that recycle their paper, food waste is commonly the single largest element remaining in the waste stream.

In a school setting, a vermicomposting system can set the stage for teaching children about a number of different topics. While the biological and environmental lessons associated with vermicomposting are quite evident, teachers have used their worms to teach about a broad range of topics in an integrated curriculum. Appendix A contains a list of educational resources for incorporating vermicomposting into the classroom.

This guide is designed to help the reader get a vermicomposting system started and provide references for curricula materials. While the information presented is written with teachers and schools staff in mind as the primary audience, the vermicomposting methods presented have broad applicability to institutions, offices and homes.

# The Basics Of Vermicomposting

In short, vermicomposting involves setting up some type of container (hereafter called a bin); filling it with moist bedding materials; introducing worms and feeding them on a regular basis; monitoring the conditions in the bin; and adding food, water, and more bedding as the conditions warrant. It sounds simple and it basically is. However, worms are living creatures and attention does need to be paid to ensure that their living environment meets their needs. Here are some more details.

## The Worm Bin

Worm bins can vary in size and material type. Bin sizes can range from small shoe-box-sized bins up to large 4 ft by 8 ft by 2 ft worm "estates." Obviously, the larger the bin, the more worms it will house and the more food waste they will consume. While several schools vermicompost nearly all of the food waste they generate and have a set of 4 ft by 8 ft bins, by far the most common type of classroom bin is a converted plastic storage box of approximately 18 gallons in capacity.

The main attributes of a good bin are that it keeps the light out, has a snug-fitting lid (for classroom bins), provides for ventilation and drainage, and is big enough to handle the desired amount of food waste. The 18-gallon-sized bins can be started with 1,000 worms (1 pound) which, once acclimated, will process approximately one-half to one pound of waste a day.

Converting a storage box is relatively easy and requires only creating small holes in the box. Appendix B contains plans for both a plastic bin and a wood bin. Several vendors throughout the nation sell deluxe ready-to-use plastic bins. Appendix D contains a list of some of the bin suppliers.

### Bin Options

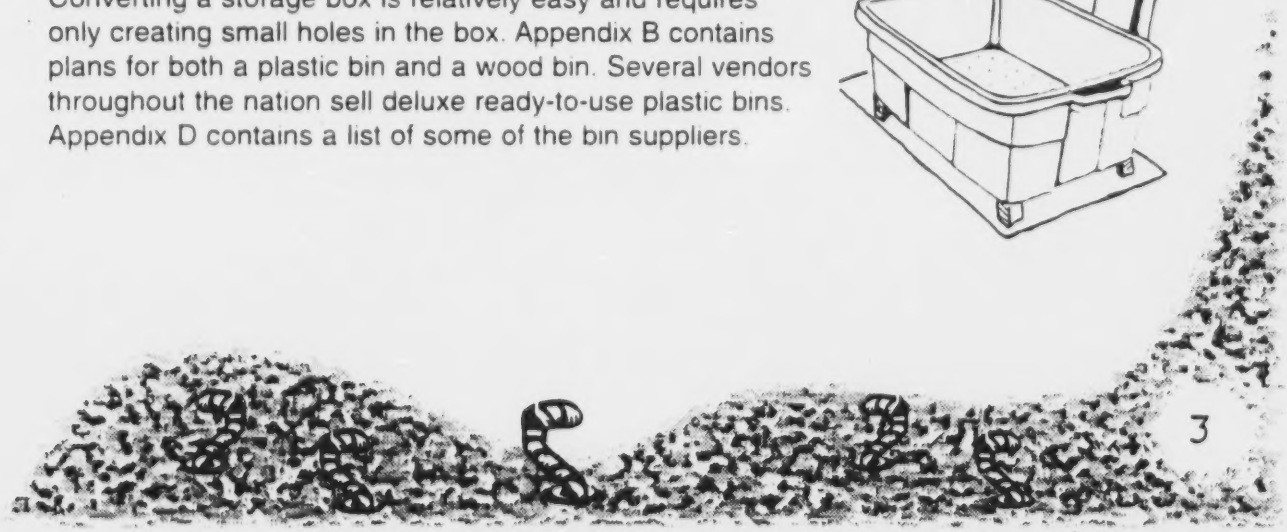
*Contact local businesses*

*An automotive export company or furniture store may have wooden crates. You can add hinges to the crates to make lids.*

*Lumber stores may have excess wood they will donate.*

*Hardware stores may offer a discount for schools purchasing plastic bins with lids.*

*Contact the California Integrated Waste Management Board's CALMAX/KIDMAX program to help you identify businesses interested in donating free materials. CALMAX offers a free quarterly catalog of materials available and wanted, also available on the web at www.ciwmb.ca.gov/calmax. To receive more information call (800) 553-2962.*



**"A pint is a pound the world around."**

*A general rule for adding water and paper is a 3:1 ratio. For an 18-gallon classroom worm bin, shred 5 pounds of paper. Then add approximately 15 pints of water. Fluff up the paper, so it does not become matted down. The paper level will decrease as the worms consume the paper and the food, so more paper will need to be added over time. Once the worm bin is operating you should only need to add dry shredded paper to the top. The moisture in the bin will dampen the paper naturally.*

## Where to Put the Bin

Worms should ideally be kept in an environment that is 55 to 77 degrees Fahrenheit. Because of this, indoor locations are usually preferable for classroom or home bins. The larger bins, however, can be kept outside because the thicker wood bin and larger mass of the vermicompost insulates the worms and protects them from relatively extreme temperatures. In most areas of California, a shady location will probably be best. In areas with very extreme climates, extra insulation (usually hard foam core) may be needed to keep the worms active in outdoor bins. (Note: Worms will live at temperatures both above and below the 55-77 range. In general, the larger the bin, the greater the temperature flexibility.)

## Worm Bedding

Once the bin is made, bedding needs to be added. The bedding provides a moist home for the worms, provides the proper carbon-nitrogen balance, and covers the food waste to minimize odors. The bedding should be at least 6 inches deep after moistening. The bedding will be consumed along with the food waste to become vermicompost.

Shredded paper is the most common worm bedding because it is readily available to most vermicomposters. While newspaper is usually used at homes, the white paper found in schools, offices, and institutions also makes an excellent bedding material. Glossy advertisements and magazines should be avoided. To turn paper into bedding, simply tear the paper into long one-inch-wide strips. If it is difficult to tear, try tearing in the other direction and it should be easier. Other common bedding materials include composted manure (not too fresh or hot) and shredded corrugated cardboard.

As a general rule, fill the bin with dry bedding material and then dampen it to a point where it is thoroughly wet but not dripping wet. "As damp as a wrung-out sponge" is commonly used to describe the proper moisture level of the bedding. The worms can be harmed if the bedding is too dry or too wet. A 3 to 1 ratio (by weight) of water to bedding is a general guideline. A pint of water weighs approximately a pound. (see side-bar)

## Obtaining Worms

A plastic box with moistened shredded newspaper in it won't be an effective vermicomposting system without...WORMS! Once you get them, place the worms on the bedding material and watch them burrow. Within ten minutes, they should all have disappeared into the bedding.

"Red wigglers" are the species of worm commonly used for vermicomposting. Also known as redworms and manure worms, red wigglers thrive in high-nutrient environments and like to live close to the surface. They are commonly sold in one-half pound increments and start at about $15 a pound. Appendix C is a listing of worm suppliers known by the California Integrated Waste Management Board. Many of these suppliers will ship worms via the mail. Bait shops often sell redworms but offer them in much smaller lots. Remember, one pound of worms will consume one-half to one pound of food waste and bedding a day.

Rather than buying worms, you may want to ask a friend who has a worm bin to share some of her or his worms, or look for them in piles of composted manure. (Yes, this may sound crazy, but if the manure is fresh, smelly, and messy, don't look in it. It's the aged, less-smelly manure that's more likely to have the worms.)

Barring a worm tragedy, you should not have to buy more worms once you get your bin started. In fact, a properly balanced bin will produce enough worms to share with others. Extra worms can be used to start a second bin, shared with a friend, or sold for fish bait. Releasing extra worms into the garden is not good because this is not their normal habitat and will be detrimental to the worms. However, they are a wonderful addition to a compost pile.

The worms commonly found in the garden are NOT the type of worms that go in a worm bin. Nightcrawlers and other garden worms like to burrow deeply in the soil and do not like to be disturbed. They will not be happy in a worm bin and will probably die. Do not try to use these worms for vermicomposting unless you are doing a comparative educational study or other designed experiment.

## Financing Tips

*Purchasing materials to build worm bins can be kept to a minimum. Contact local businesses that might have resources they can donate to your project. The following organizations may be able to assist you by providing funding and/or resources for your vermicomposting program:*

*Agriculture districts*

*Local government solid waste offices*

*Local hardware and lumber stores*

*Home savings and loan offices (offer community service grants)*

*Association of Nurserymen (local chapters)*

*Community master gardeners*

*Community service organizations (Kiwanis, Rotary, etc.)*

*PTA and booster clubs*

*Community and urban conservation corps*

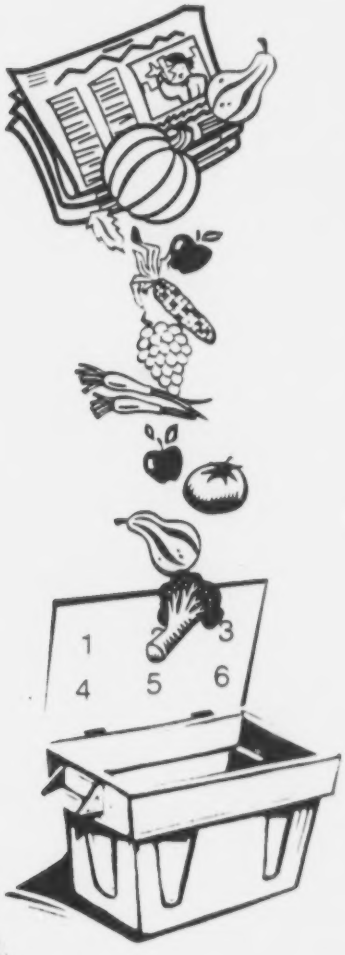
*Local recycling and composting companies*

### Worm Bin Ideas

*Place the worm bin on the floor, so students have easy access to the bin.*

*Use a clear plastic bin for your worm bin. This will enable students to view the worms. Remember to cover the bin with a towel to keep out light.*

*What about vacations? Send the worm bin home with an enthusiastic student.*




## Feeding the Worms

Man does not live on bread and water alone and your worms shouldn't have to live on paper and water alone. Here's where the food waste comes in.

### What to Feed Them

You could say that worms need a low-fat diet. That's right, the advice that the American Heart Association offers for humans works for the worms too! In real terms, this means no meat, no dairy, and only minimal amounts of oily foods in the worm bin. Fruits, vegetables, coffee grounds, and grains are all welcome additions. You may find that some foods decompose more slowly than others. It is best to chop up really large items and crush egg shells well to help the process along. Care should be taken to not overload the bin with acidic items. In other words, if you make fresh orange juice for the class, don't fill the bin with orange peels.

### Placing the Food

The food waste should be placed under the bedding material or dug into the worm castings and not left on the surface. This will minimize the food's potential for odors and attractiveness to fruit flies. Add additional bedding when necessary. Rotate the burial of the food waste throughout the bin. You may want to use a marker or make a chart to help you keep track of where you fed the worms last. Many people start in one corner and work their way around until they return to that corner-and then repeat the pattern.

### How Much to Feed?

In general, err toward underfeeding rather than overfeeding. If you get back to your initial placement location and find that not much of the food has been eaten, consider reducing the feeding schedule or stopping for awhile altogether. While a bin that's getting fed less than it can handle will not produce worms as quickly as it would if it received the perfect amount of food, a bin that's getting overfed can smell bad, will have lots of excess moisture, and can result in massive worm death.
IMPORTANT NOTE: Newly started bins should be fed

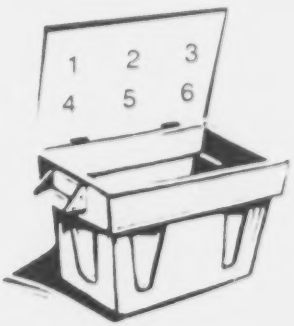
## Feeding Your Worms With Food Scraps

| Do Feed | Do Not Feed |
|---|---|
| Vegetables | Meat |
| Fruits | Fish and Poultry |
| Coffee grounds & filters | Cheese |
| Tea bags | Oils and Oily foods |
| Grains | Butter |
| Breads | Non-foods (plastics, metals) |
| Pasta | |
| Paper | |

lightly at first until the worms acclimate and become comfortable (and hungry) in their new surroundings.

With this in mind, you can schedule daily small feedings or less frequent larger feedings. Feeding should probably occur at least biweekly. This decision should be based on convenience and educational goals. It will be necessary to feed the worms during a school's summer vacation and you may want to take the bin home with you or ask a student to take the bin home during the summer.

The best method for determining how much to feed your worms is OBSERVATION. Divide the bin into quadrants/burial sites, so students can keep track of where they deposited food. Have students monitor the amount and type of food. Rotate the burial sites. When they reach the first burial site, and there is still quite a bit of food left, put the worms on a diet. Allow the worms time to process the food in the bin before continuing feeding. This will prevent overloading the system.




**Label quadrants on the lid of the box.**

### Preparing the Food

The smaller the pieces of food, the faster the worms can eat. Cut up large pieces of vegetables and fruits. Shred paper napkins, towels, homework, etc. Some vegetables can take a long time to break down including carrots, broccoli stems, grape stems. Your class may choose to feed your worms weekly. If you choose to store the food, keep it in a tightly sealed container such as a coffee can with lid.

**Worms have no teeth—**

*instead they have a muscular gizzard, which functions similarly to that of birds. Small grains of sand and mineral particles lodge in this gizzard. Muscular contractions compress these hard materials against each other and the food, mix it with some fluid, and grind it into smaller particles.*

## Other Things to Add to the Bin

Worms have gizzards and need a small amount of gritty material to help grind up the food waste. A handful of soil added to the bin will work. Before adding the soil, check to make sure that the area that the soil came from was not recently treated with pesticides.

An even better source of grit is rock dust. Rock dust is ground up rocks. Many nurseries and garden stores sell bags of rock dust. It is rich in minerals and will help balance the acidity of the bin.

## Monitoring the Bin

When feeding the worms, it is a good idea to check the overall conditions of the bin. If children do the feeding, you may want to have them record certain bin conditions as a way of both monitoring the bin and teaching them about experimental observation.

Things you may want to add after starting the bin:

**More Padding**

- You may want to add additional bedding if:

  a) There is excess moisture in the bin (add DRY bedding, not moist).

  b) There are lots of fruit flies in the bin.

  c) The existing material is reduced down and you want to continue feeding without harvesting.

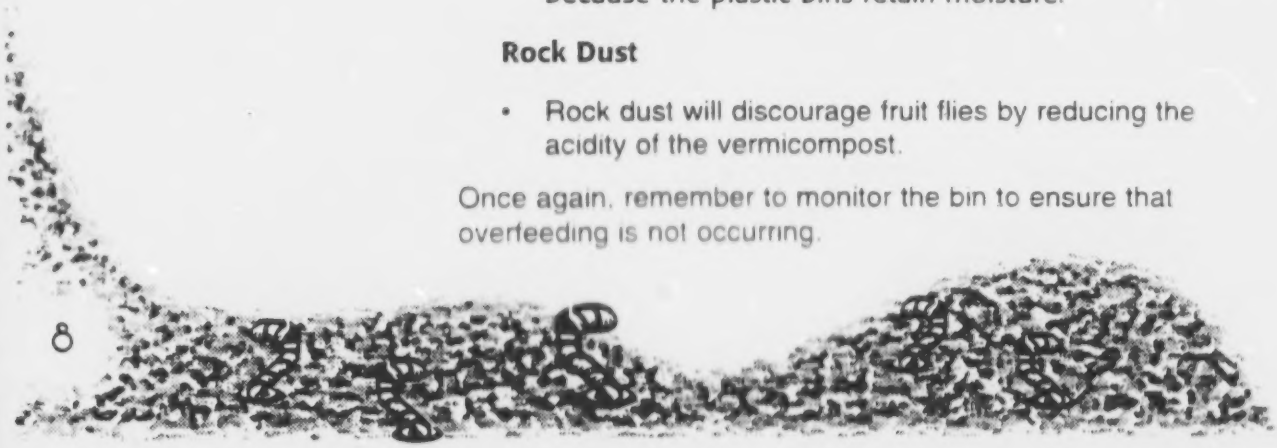
**Water**

- You may need to add additional water if the bedding looks too dry. This usually only occurs in wood bins because the plastic bins retain moisture.

**Rock Dust**

- Rock dust will discourage fruit flies by reducing the acidity of the vermicompost.

Once again, remember to monitor the bin to ensure that overfeeding is not occurring.



## Harvesting the Vermicompost

You will know your vermicompost is ready when you no longer see food and paper in sections of the bin. The finished product should be rich, black, and relatively homogenous.

To prepare for harvesting, you will need to stop feeding the worms in all or part of your bin. This enables the worms to finish off the remaining food and paper, creating a finished product. At this point, it is common to feed in one-half of the bin and wait for the other half to finish. In time, the worms will migrate over to the section still being fed. If you have multiple bins, set up a schedule in which you stop feeding one bin at a time. In this way, you can keep handling food waste in the other bin(s) and still facilitate your vermicompost harvest.

Once the area that you haven't been feeding looks like it has finished vermicompost in it, it's time to harvest. (Note: Some people prefer to wait until all of the paper and food has been vermicomposted, while others prefer to remove the last bits of unvermicomposted material and place them in a new bin for additional processing.) Since there will almost certainly still be worms in the finished area, a simple worm sorting process should be followed.

Place a tarp or paper on the ground or on a table in a well-lit area. Scoop out some vermicompost and place it on the tarp or paper. Since the worms don't like the light, they will burrow down into the vermicompost. Remove the top layer of vermicompost, which will now be relatively worm-free, and place it in a container. Repeat the process until you are left with a small amount of vermicompost and lots of worms. Place these worms into a different container.

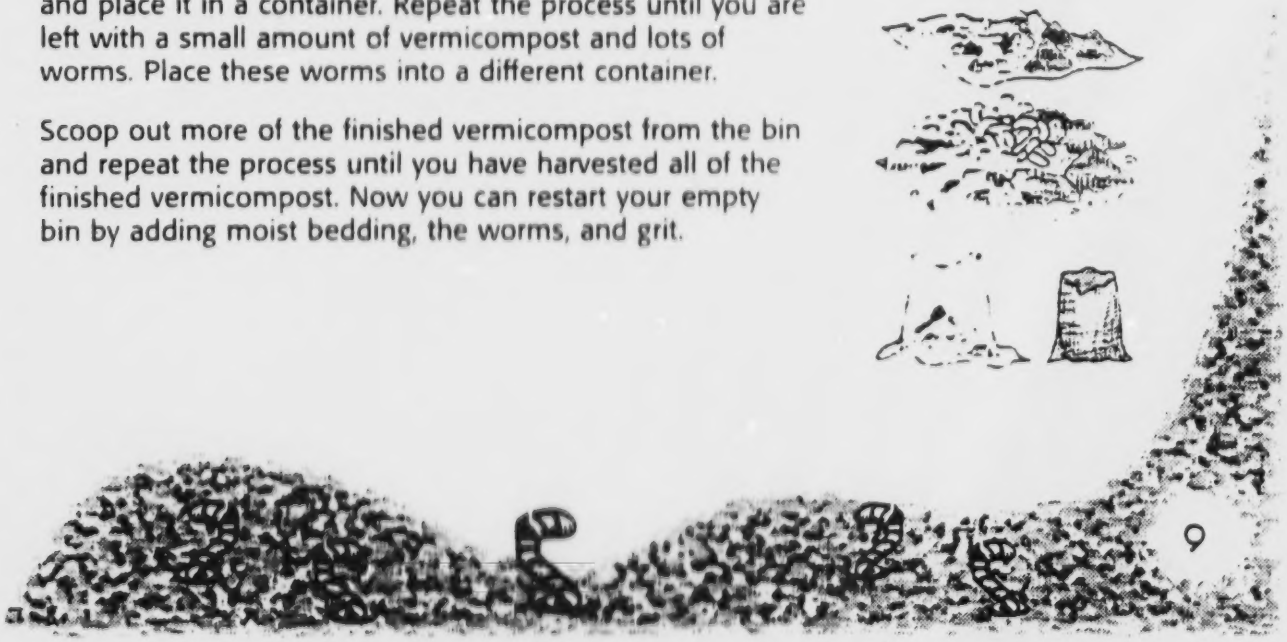
Scoop out more of the finished vermicompost from the bin and repeat the process until you have harvested all of the finished vermicompost. Now you can restart your empty bin by adding moist bedding, the worms, and grit.

### More Harvesting Ideas

*Allow the worms to finish eating the remaining food in the worm bin. Then place food in a lingerie bag and set the bag in the worm bin. The worms will climb through the holes in the lingerie bag to reach the food. At this point you will be able to remove the castings.*

*Prepare a new bin with moist bedding. Place the new bin so it rests on the bedding of the ready-to-harvest bin. Bury food in the new bin. The worms will migrate up through the holes of the new bin. Then harvest the castings from the old bin.*

*There are many options for harvesting the castings. Have your students design their own methods for harvesting.*





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## Fundraising Ideas

During a science fair or PTA event, auction off a worm bin.

Package and sell worm castings to parents and community gardeners.

Establish a partnership with a local bait shop to sell redworms.

Grow plants with worm casting-enriched soil and host a plant sale.

Create worm starter kit which could include worm castings, red worms, and an instructional packet on how to get started.

## Harvesting Larger Bins

With larger bins, it may be rather cumbersome to sort through all of the vermicompost for the worms. Therefore, it is recommended that you only feed one portion of the bin and wait for the worms to migrate over to the fresh food source. It could take a month or more for the migration to happen.

In addition, deep bins may have a considerable amount of finished vermicompost underneath the unprocessed food and bedding. If the selective feeding method will take too long, you may want to consider removing the top six inches or so of unfinished food waste and bedding, setting this material aside, and harvesting the vermicompost underneath it. Most of the worms will be in the unfinished top section of the bin. After you've completed harvesting the bin, place the unfinished material back in the bin for further processing.

## Using the Vermicompost

Once you've harvested the vermicompost from the bin, place it in the garden, in houseplants, or in outdoor pots. It's an excellent material to start seeds in because it's chocked full of natural nutrients. You may want to consider selling the vermicompost or extra worms as a fundraising experience for the students.

# Troubleshooting Guide

| SYMPTOM | PROBLEM | SOLUTION |
|---|---|---|
| **Strong Bad Smell** | Not enough air circulation. | Add more bedding/aerate by turning the compost. |
| | Too much food. | Feed worms less. |
| | Improper food added. | Remove animal products. |
| **Fruit Flies** | Food exposed. | Cover food deeper in bedding. |
| | Acidic environment. | Add rock dust. |
| **Dead Worms** | Bin too moist or too dry. | Add more bedding or water. |
| | Not enough food. | Add food to bin. |
| **Ant Infestation** | Ants found the bin. | Put sticky ant traps on bin legs or immerse bin legs in liquid. |
| | Bedding may be too dry. | Spritz with water. |
| **Dry Bedding** | Bin is not retaining moisture. | Spritz with water. Cover bedding with a t-shirt, plastic, or burlap sack. |
| **Mite Infestation** (brown-to-reddish color) | Mite population is high. | Discontinue feeding foods with high moisture content. |
| **Worms Not Feeding** | Ensure bin has proper drainage. | Expose the bed to the sun for a few hours. Cut down on amounts of feed and water. |

# Worm Facts

## Reproduction

Redworms are hermaphrodites, equipped with both male and female organs. Redworms reproduce by joining together with mucus produced at the clitellum, a round band around the midsection. Each worm has both ovaries and testes. When the worms join, sperm passes from each worm to the other's sperm storage sac. As the mucus hardens, a cocoon forms. As the worms back out of the cocoon, eggs and sperm are deposited into the cocoon. The cocoon seals itself, fertilization takes place inside the cocoon, and within a few weeks two or more baby worms hatch out of the cocoon. Redworms take approximately four to six weeks to mature between hatching and commencing reproduction.

When temperature, moisture, and food are favorable, a mature redworm can mate and produce two to three cocoons per week. Cocoons look like tiny, brownish lemons. After hatching out of the cocoon, baby worms appear small and transparent.

## Respiration

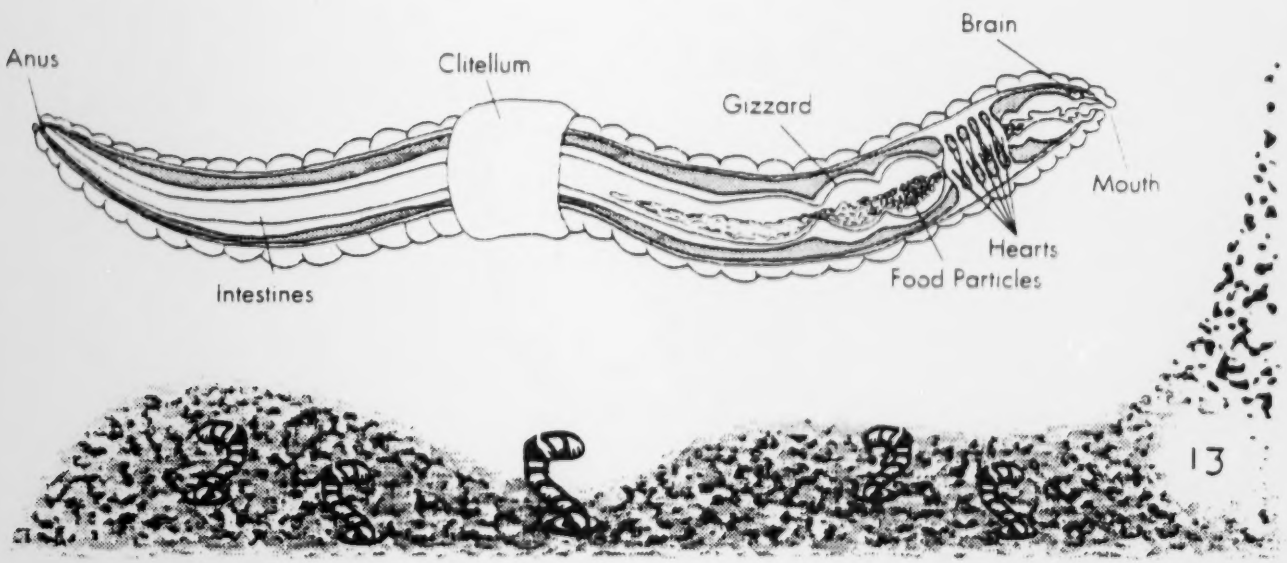
Unlike humans, worms have no lungs. Worms respire through the entire surface of their bodies. Oxygen dissolves in the moisture on the worms' body. Oxygen then passes into the body and the bloodstream. Worms need enough moisture to keep their skins wet, but not enough to drown them. Worms are not aquatic animals, but some species can live under water if there is enough oxygen dissolved in the water. Without moisture, however, the worms will die.

## Ingestion

How much garbage can worms eat? A worm can consume about one-half of its weight each day. A worm weighing 1 gram might eat 1/2 gram of food in one day. The bedding in the worm bin disappears as it, in addition to the food, is consumed and converted to castings.

## Digestion

Microorganisms such as bacteria and fungi aid worms, which do not have teeth, by breaking down pieces of food. Bacteria act as digesters, and fungi break down cellulose. A redworm's mouth has



a small sensitive pad of flesh, called the prostomium, that protrudes above its mouth and stretches out to sense suitable food particles. Worms have a muscular gizzard, which functions similarly to that of birds. Small grains of sand and mineral particles lodge in this gizzard. Muscular contractions compress these hard materials against each other and the food, mix it with some fluid, and grind it into smaller particles. Undigested matter such as soil will pass through the worm's long intestine. The tiny, dark-colored masses the worms deposit are called worm castings. Other names for worm castings are worm manure or worm feces. Castings contain thousands of bacteria, humus, and many nutrients that help plants to grow.

## Locomotion

Worms move by contracting and relaxing their muscles in waves, alternating between circular and long muscles. Contraction of the circular muscles forces the worm's body forward. Then the long muscles contract, drawing the tail end of the worm towards the skinny front end. When the long muscles contract, the circular muscles relax, causing the worm to become thick. To keep from skidding during movement, tiny bristles called setae act as brakes to hold part of the worm's body against the surface. The worm moves forward and backward in similar ways.

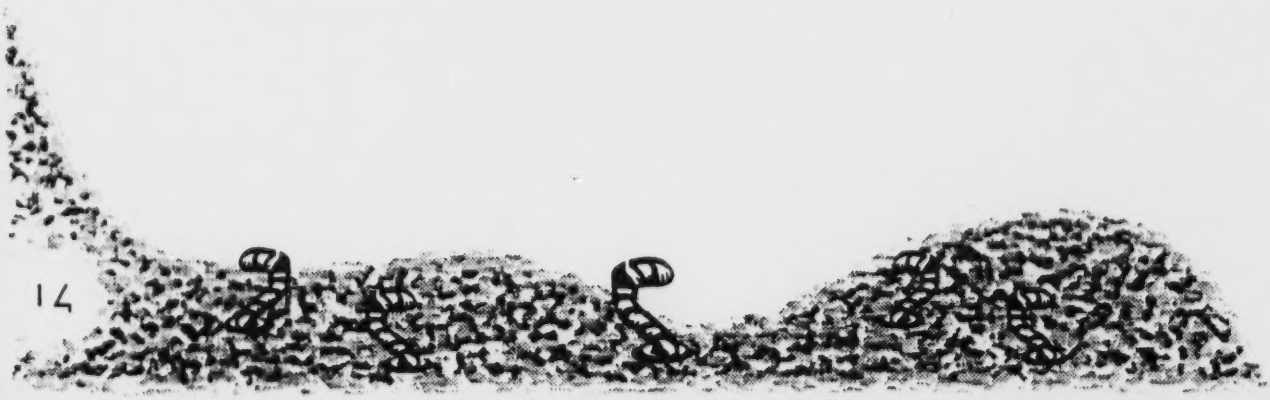
## Other Worm Facts

Most worms probably live and die within the same year, although they can live longer.

Redworms have no eyes and cannot see but they use light-sensitive skin cells, concentrated at the front end of their bodies, to sense light and move away from it.

Although worms are very prolific, they will automatically keep their numbers in check in a worm box.

Contrary to folklore, if a worm is cut in half, both halves do not regenerate. A worm can replace a limited number of front or hind segments, but only if it still has a middle.



# Vermicomposting Classroom Activities

## Vermicomposting Project Activities

### Brainstorming

A. Student groups brainstorm "What is vermicomposting?" Record ideas of each group for sharing.

   After sharing, provide definition so students can compare with their ideas. (Vermicomposting is a system that uses redworms to process/eat kitchen waste, resulting in worm castings that are rich in nutrients and can be used as fertilizer for plants).

B. Student groups brainstorm questions they have about vermicomposting. Have the groups share and list the most common questions. Assign each group to research assigned questions from the list and share with the class.

### Preparation

A. Assign roles to students such as planners, bedding collectors, bedding preparers, feeders, worm keepers, etc.

B. Students draw a diagram of the worm bin from an overhead view. Students divide bin into sections and number the sections. Students use this diagram for placing food waste in different sections of the bin. This will enable students to keep track of where and when the food waste is placed.

C. Provide an overview of tasks to be completed in building and maintaining the worm bin.

### Research

A. Give pairs of students materials that an earthworm processes to produce worm castings (soil, sand, newspaper in very small amounts, and grass clippings). Have them experiment with these materials to see if they can produce something similar to castings. Have students share the results of their experiments.

B. Assign teams to think about and then draw an illustration of the vermicomposting cycle (building a bin, preparing the bedding, adding the worms, adding the food waste, harvesting the castings, fertilizing the garden, growing vegetables, eating the vegetables, feeding vegetable waste to the worms). Assign students to think about the cycle and identify additional possibilities for expanding the cycle (e.g., rabbits in cages above the worm bins being fed lettuce grown from castings, rabbit droppings and lettuce waste feed earthworms).

## Recordkeeping

A. Discuss with students how to use a thermometer. Have students practice recording temperatures. Assign students to record temperatures in worm bin, maintain a log of temperatures. Have students graph temperatures over a period of time.

B. Have students measure and record amount and types of food given to the worms. Have students graph amounts of food over a period of time. Ask students to identify foods that are easy/hard to vermicompost based on their observations.

## Observation

A. Assign pairs of students to observe the activity of the worms when food waste is buried. Students record their observations in their journals and share with other students in their group.

B. Pairs of students collect a small sample of composted material from the worm bin to observe under a magnifying lens. Students record their observations in their journals and share with other students.

## Assessment

A. Have students discuss these questions with a partner and then share their ideas with the class. "What does "closing the loop" mean to you?" "How do worms close the loop?" "Why are worms important?"

Name _____

# Warming Up To Worms

Place your worm on a damp paper towel where you can observe it.

1. What color is the worm?

_____

2. What shape is a worm? Describe it.

_____

_____

3. How does the worm's skin feel?

_____

4. Is there a difference between the top side and bottom side of a worm? (Turn the worm over.) Describe what each side is like.

_____

_____

5. Can you tell which is the front end of a worm and which is the back end? How do you know?

_____

_____

Adapted from AIMS Education Foundation *Critters*. 1992

Name _____

# My Worm

My worm looks like _____

_____

_____

_____

My worm feels _____

_____

_____

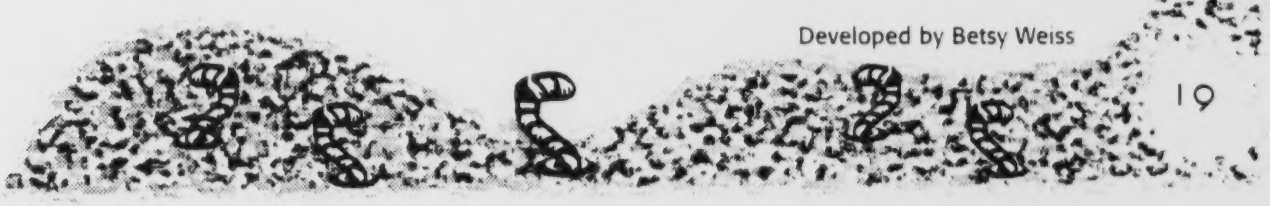
My worm is _____ (inches, centimeters) long.

My worm likes _____

_____

_____

_____



Developed by Betsy Weiss

# Set Up Record Sheet

Date set up _____

Initial weight of worms _____

Type of bedding _____

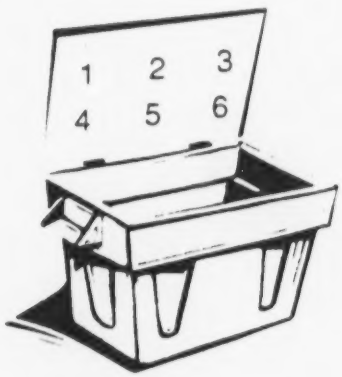
Size of bin _____

Classroom size _____

### Garbage burying locations:

Label the worm bin so you can keep track of where and when you are feeding the worms.

| | | |
|---|---|---|
| 1 | 2 | 3 |
| 6 | 5 | 4 |




# Harvest Results

Date harvested_____ No. of days total _____

Worm weight_____

**Calculate the following from the Feeding Record Sheet:**

Total weight buried garbage _____

Weight uneaten garbage_____

Average oz. buried per day_____

Average temp._____ Temp. range _____

# Feeding Record Sheet

| Date | # oz. food | Total # oz. to date | Temp. | Water (# pints) | Burying location # | Type of food |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

# Worm Population Count

We started on _____ with approximately _____ worms.
(date)

On _____ there were _____ worms.
(date)

1. Are there more or less? _____

2. Why do you think the number of worms changed?

_____

_____

3. What did you observe about the contents of the worm bin?

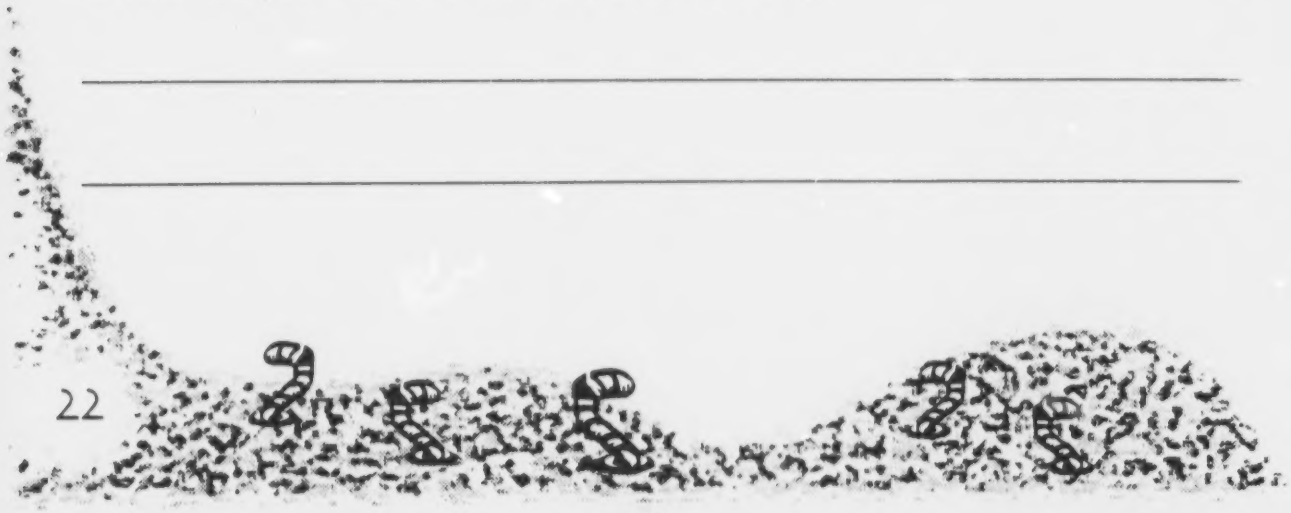
_____

_____

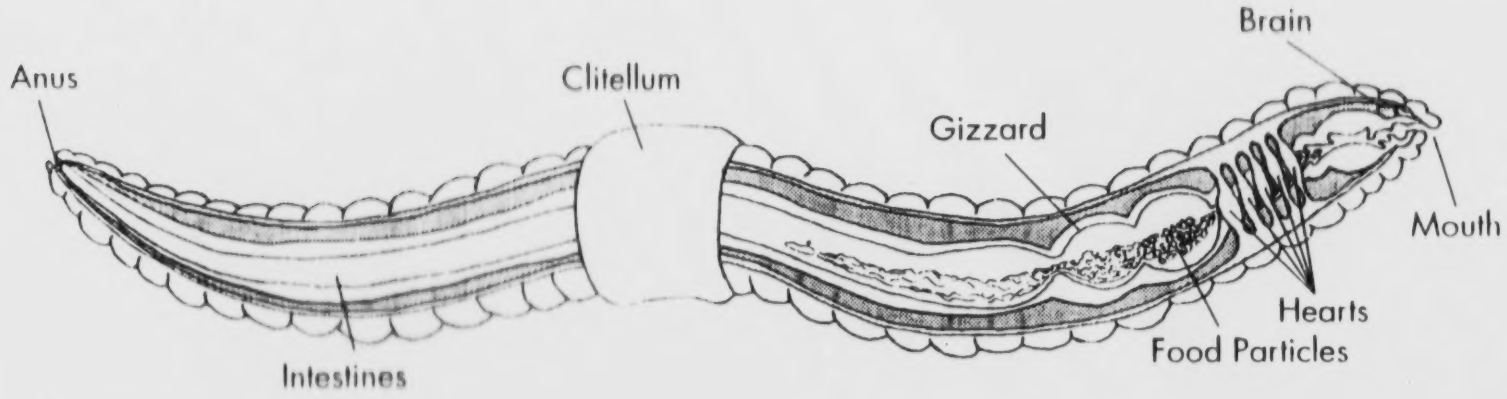
4. What do you think the worms like to eat? Why?

_____

_____



# Worm Anatomy




### Brain

A worm's brain is primitive, but has kept worms alive for hundreds of millions of years. The worm has a large nerve that runs along its body and a clump of nerves that ends in its head. These nerves control the worm's actions.

### Mouth

A worm has a small pad of flesh that sticks out above its mouth. When the worm is hungry, the pad stretches out searching for food. When the worm finds something to eat, the pad pulls the food into the mouth and closes over the mouth.

### Hearts

Worms have five hearts. The hearts pump blood throughout the worm's body. The blood carries the digested food particles to where they are needed.

### Gizzard

Worms do not have teeth. They grind their food into tiny pieces in a part of their body called a gizzard. Hard particles such as sand and dirt collect in the worm's gizzard. The hard particles rub against each other and help grind the food into small pieces.

### Intestine

The intestine or digestive tract is a canal that moves the food along. Strong juices in the digestive tract break down the food bits into even smaller pieces. Food that is not absorbed into the bloodstream is passed out through the worm's anus. The waste material is called a casting.

### Clitellum

The clitellum is a light colored band on the worm's body. The clitellum has a role in fertilization. The clitellum makes mucus when two worms join to exchange sperm.



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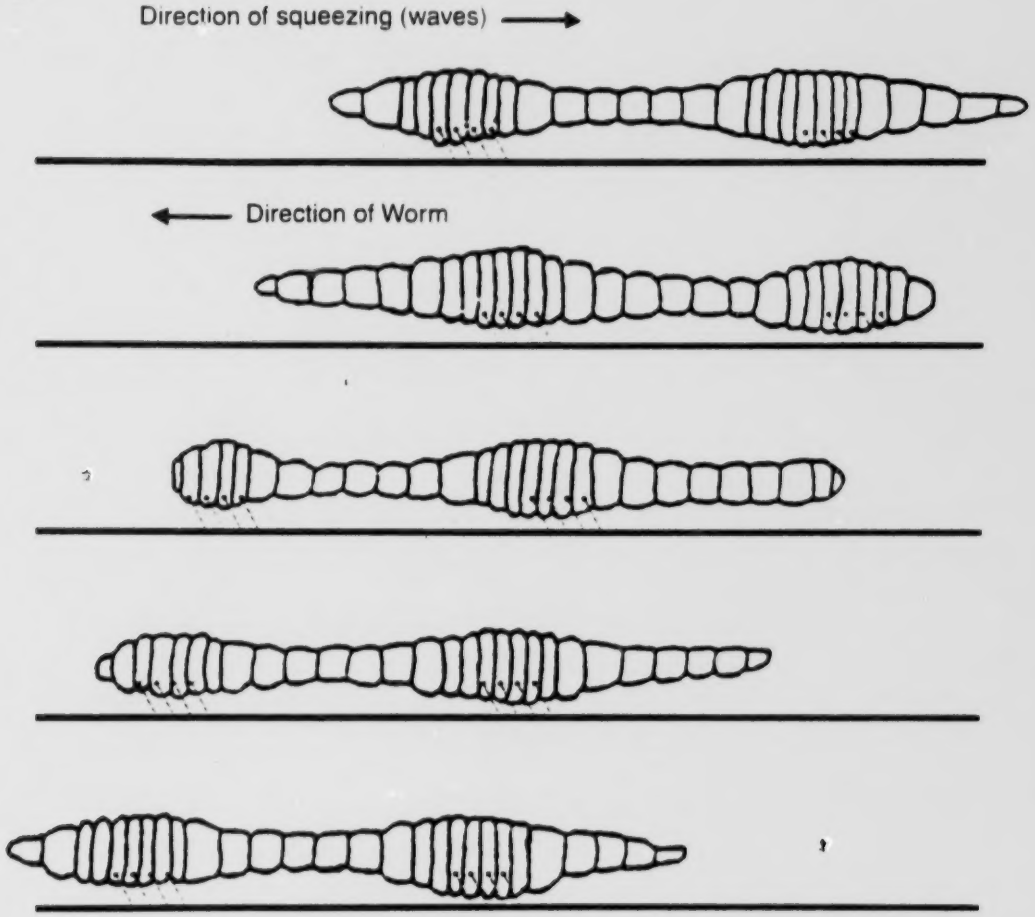
# Worm Walk

When a worm wants to move forward, its powerful muscles contract and it squeezes itself around the middle (sort of like when you squeeze a tube of toothpaste). The worm's front gets long and thin and burrows ahead. Then another set of muscles squeezes and makes the worm fat. It pushes its setae (bristles) down and grips the burrow while the rear section catches up with the front section.

Worms can force their way through soft earth; they must eat their way through harder soil. Eaten earth passes through their intestines and is deposited on the ground's surface as castings.




Adapted from *The Reasons for Seasons*, by Linda Allison. Yolla Bolly Press/Little, Brown, and Co. Boston, 1975.

Name _____

# My Worm Story

My worm's name is _____

My worm is _____ inches long.

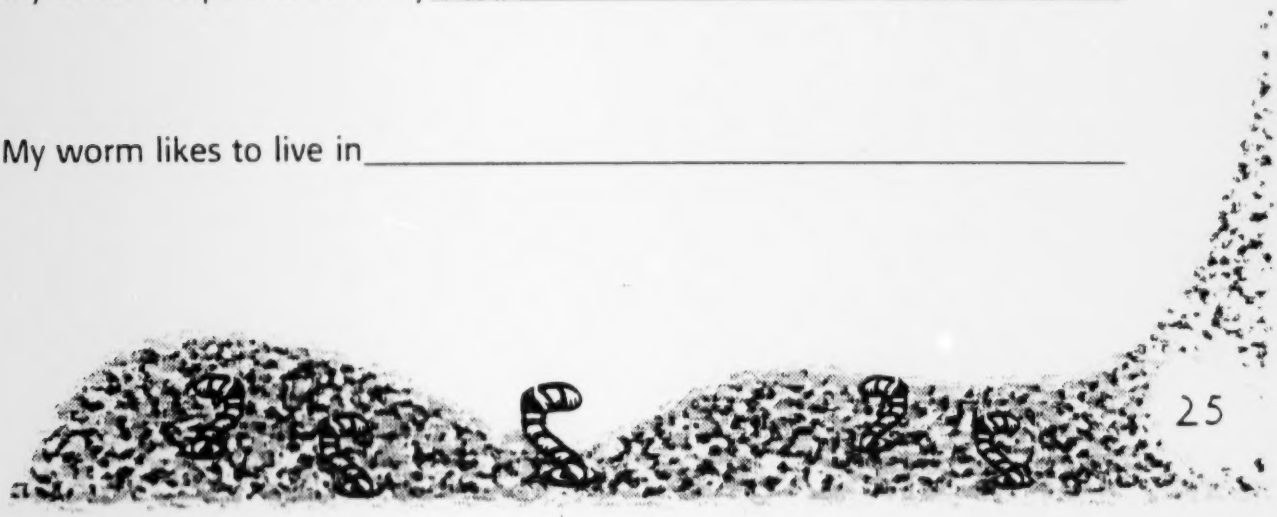
My worm feels like _____

My worm likes to move by _____

My worm likes to eat _____

My worm helps the earth by _____

My worm likes to live in _____



## *"Willy the Worm"*

"Willy the Worm" is a preposition book.

Students draw their pictures above the sentences they complete. The following pages are set up so you can count the pages in half and make two books from each page.

*Will the Worm* was developed by second grade teachers from Cupertino Unified School district.

Name _____

**Willy the worm went for a squirm.**

---

Name _____

**Willy the worm went for a squirm.**

**under the**_____.

**under the**_____.

**in the**_____.

**in the**_____.

over the_____.

over the_____.

across the_____.

across the_____.

through the_____.

through the_____.

32

**and back to_____.**

---

**and back to_____.**

33

Name _____

# Red Worm Observation

Draw a picture of a red worm. Can you label the parts?
(head, tail, mouth, segments, band)

Draw lines pointing to the parts and write the names on the lines.

Write three observations about the worm.

1. _____

2. _____

3. _____

*Collector Name* _____

*Recorder Name* _____

*Reporter Name* _____

# What Does Your Worm Prefer?

1. Light or dark? _____

2. Wet or dry? _____

3. On top of soil or underground? _____

Developed by Betsy Weiss

# Lab Activities

The following lab activities provide an engaging opportunity for students to learn about the important role worms play in nature. The primary goal of the activities is for students to perform the experiments and draw their own conclusions. As an extension, you may want to have students design their own experiments using the scientific method—posing an idea, forming a hypothesis, constructing an experiment, analyzing results, and presenting conclusions.

To address the negative attitudes towards worms, present the lab activities as an opportunity to learn more about a creature that is vital to recycling nutrients in the soil and helping us to grow nutritious food. You may want to pair squeamish students with others who are less concerned about working with the worms.

Tell students that while working with the worms they should keep them moist by placing them on a moist paper towel or in a petri dish with water. Explain to students that the worms breathe through their wet skin, and therefore must be kept moist.

Following the lab descriptions are sample station cards. You might want to set these labs up at stations and have students rotate through. Allow students ample time to observe and record their findings for each lab activity.

**1. Tell the students they are going to observe the red worms living in the compost bin. Ask, "What do you know about redworms?" "What do they do?" "Where do they live?" "What do they eat?"**

While many students are familiar with worms, most have not taken the opportunity to observe them closely. List students' responses and refer back to them as they learn more about the worms. Redworms (Eisenia foetida), also called manure worms or red wigglers, are the type of worm used in worm composting systems because they are litter dwellers requiring organic material to live, they tolerate a wide range of temperatures, and they do not require large amounts of soil for burrowing.

Have students use a hand lens to observe the worms. To find out which is the front end, students should observe how the worm moves and which end leads the body. When the worm moves the front (head) end usually goes first. Another distinguishing feature is the clitellum, the swelling or band which is usually distinguished by its lighter color, is nearer to the front end.

**2. Are worms sensitive to light? Do worms have eyes?**

Darken the room and ask a student to shine a beam from a flashlight covered with red cellophane on a worm. Since worms, like many nocturnal animals, are not sensitive to light from the red end of the spectrum, the worm will probably not react to the light. When the cellophane is removed the worm will react to the light by turning away. Have students

repeat the experiment with a number of worms and record their findings in their Learning Journals. As a variation, set up the experiment with the worm in a dish that is partially covered so the worm has a dark place to retreat to.

### 3. Do worms have favorite colors?

To test a worm's response to lights of various colors, shine a flashlight through a prism so it casts a spectrum on a white sheet. Place a worm in the spectrum. The worm should crawl away from the blue light and through the red. Remind students about the red cellophane on the flashlight. Are the two responses consistent with each other? How do they fit in with the environment in which worms live?

### 4. Do worms like water?

On a piece of paper place a drop of water. Place a worm near the water drop. The worm should crawl to the water. Students could also do the experiment in a box to block out the light.

### 5. When two worms are placed in the same area, will they move together or stay apart?

Place two worms in a container with a cover to block out the light. The worms should move towards each other. Have students discuss reasons the worms might move towards each other. Possible ideas might include that the worms are seeking moisture or they are looking for companionship, etc.

### 6. What is the average length of a worm?

Place a worm on a damp paper towel, straighten out the worm, and measure it with a ruler. Have students measure a number of worms and calculate the average length. Students should note the accuracy of measurement should increase by measuring a larger number of worms versus only a few.

For younger students, have them measure "gummy" worms to gain experience with measuring and recording data. Variables affecting the length of a worm include how old it is, how well fed it is and if its body has enough moisture.

### 7. Does a worm move forwards or backwards or both?

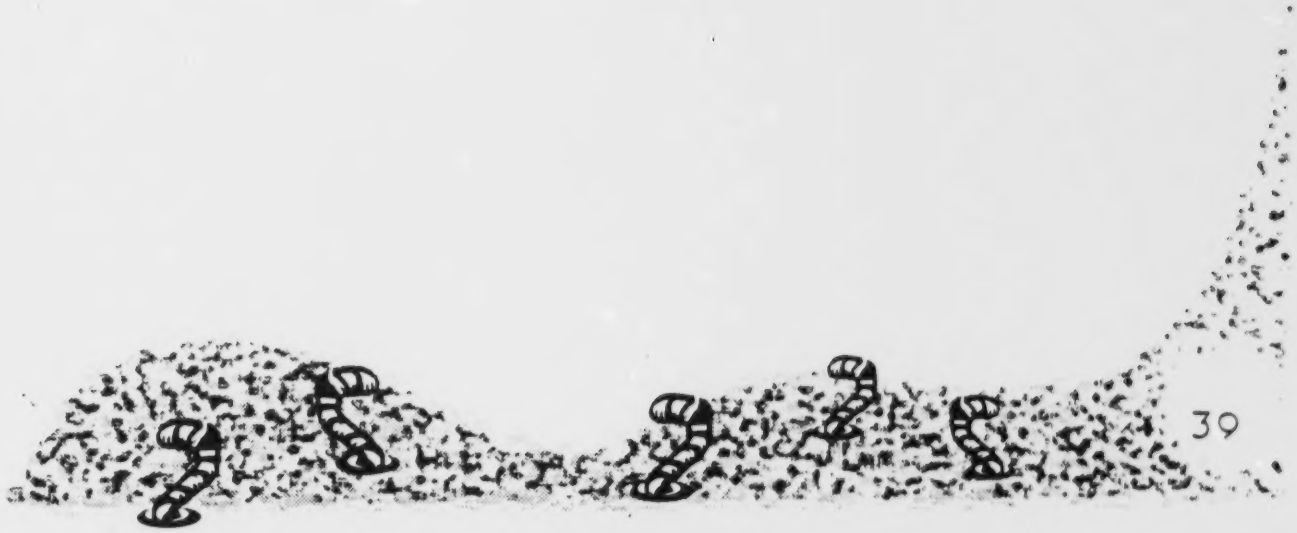
Place a worm on a moist paper towel. Using something soft such as a paint brush or leaf touch the end of the worm. The worm will move both forwards and backwards. Worms move through contracting and relaxing their muscles in waves, alternating between circular and long muscles. Contraction of the circular muscles forces the worm's body forward. Then, the long muscles contract, drawing the tail end of the worm towards the skinny front end. When the long muscles contract, the circular muscles relax, causing the worm to become thick. To keep from skidding during movement, tiny bristles called setae act as brakes to hold part of the worm's body against the surface. The worm moves forward and backward in similar ways.

### 8. Can a worm feel?

Place a worm on a moist paper towel. Using a feather and then a leaf, touch the worm and observe its reaction. The worm will respond to touch. This experiment demonstrates that worms have senses. Students may garner respect for these creatures rather than squishing them on the playground or tossing them in the air.

### 9. How do worms find food?

This is a physical education activity. In a large area set up a maze or obstacle track. Explain to students they are now redworms, therefore they have no eyes, legs or arms. They must make their way through the maze to get to their destination or food source. At the conclusion of the activity have students discuss their observations.



07

# Station #

Does a worm sense light?
Do worms have eyes?

# Station #

# Do worms have favorite colors?

42

# Station #

Does a worm like water?

43

# Station #

What happens when two worms are placed in the same area?

Will they move together or stay apart?

# Station #

What is the average length of a red worm?

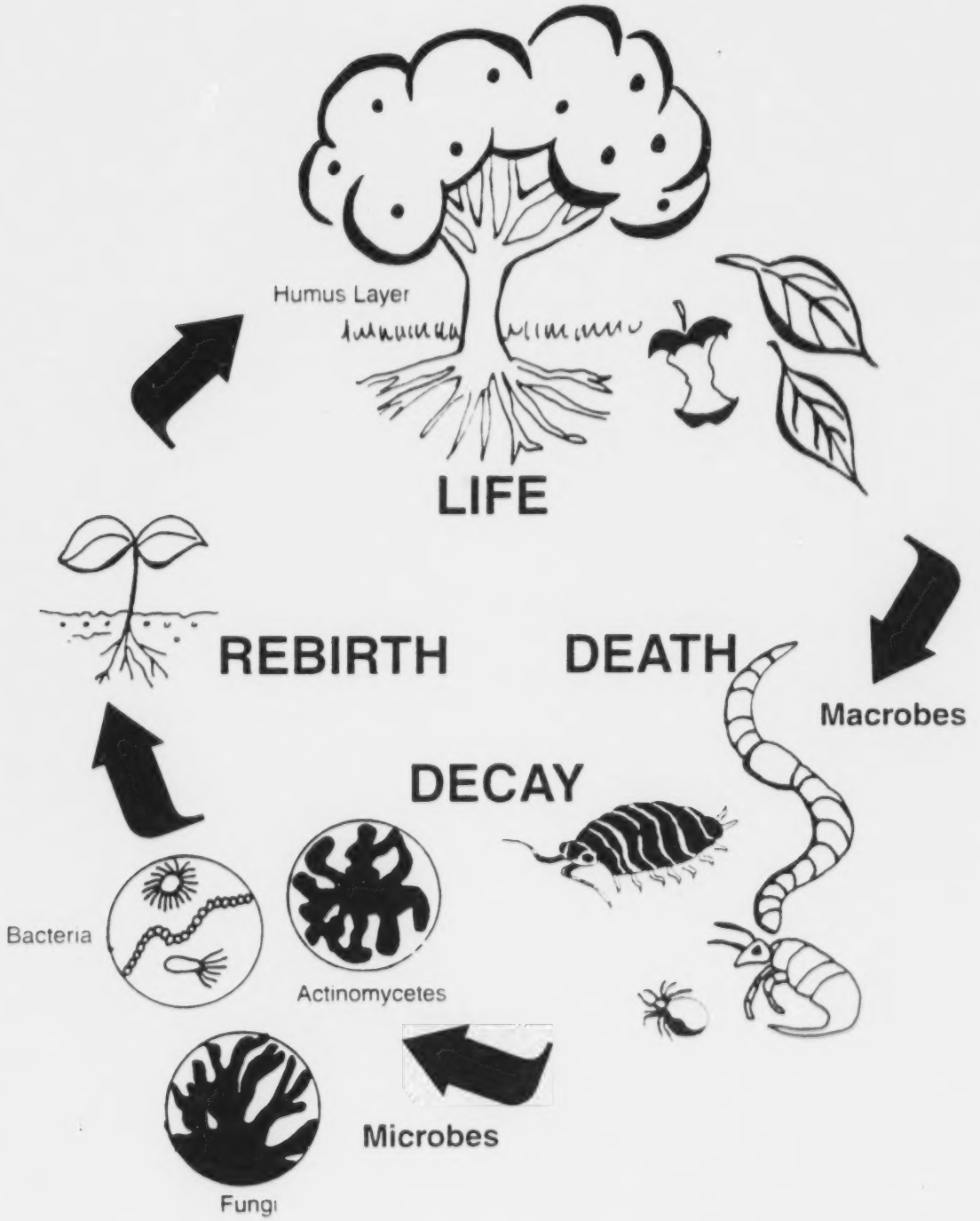
# Station #

Does a worm move forwards, backwards, or both?

# Station #

Can a worm feel?

# Soil and Decomposition



# Fungi and Bacteria

## Description

Students compare the growth of fungi and bacteria in different environments.

## Objective

Students observe growth of fungi (yeast) and the effect of bacteria as organic matter is decomposed.

## Grade

2-6

## Time

One 30-minute period, one 15-minute period and observation periods over two weeks.

## Materials

Two slices of bread for each group of students

Two lemons or oranges for each group

Several bananas

A knife for you to cut the bananas

Six plastic bags for each group

Twist ties for each bag

One-half teaspoon of yeast for each group

Cotton balls

Masking tape

Water

A warm dark place to store things for two weeks

A refrigerator or cool place to store things for two weeks

## Background Information

Fungi and bacteria are essential to the decay of plant material. Fungi and bacteria are decomposers working at the microscopic level to help plants break down into their basic elements.

Moisture and darkness encourage rapid growth of fungi and some bacteria. Both of these factors help fungi and bacteria thrive.

## Preparation

Decide on a warm, dark place for bags to be kept during the experiment.

## Procedure

Day One

1. Ask the students how they think plants decompose and what factors effect decomposition. What conditions do they think are the best to help plants decompose?
2. Explain that they are going to test how environmental conditions effect decomposition. Provide each group with six plastic bags and enough ties to secure them, two slices of bread, two oranges or lemons, and two pieces of banana.
3. In each of the two bags have the students place a slice of bread. One slice should be wet but not soggy.

Nothing should be done to the other slice. Ask the students to seal both bags with ties. Place the bag with the moistened slice in a dark warm place and the other bag in the refrigerator, or a cool place.

4. In each of the other two bags, place a piece of banana. In one bag pour half a teaspoon of yeast on the banana and mark this bag with a "Y." Place both of these bags in a warm, dark place.

5. Rub the oranges or lemons on the floor to pick up bacteria and let them sit out in the air for one day.

Day Two

6. Place each orange or lemon into a bag. Add a cotton ball moistened with water to one of the bags. Tie both bags closed. Place the bag with the cotton ball in a warm, dark place and the other bag in a cool spot.

7. Have the students hypothesize what will happen to each of the items. What will the yeast do? What affect will temperature and light have?

**During The Week**

8. Twice during the week have students observe each bag and record their observations on the worksheet.

**After One Week**

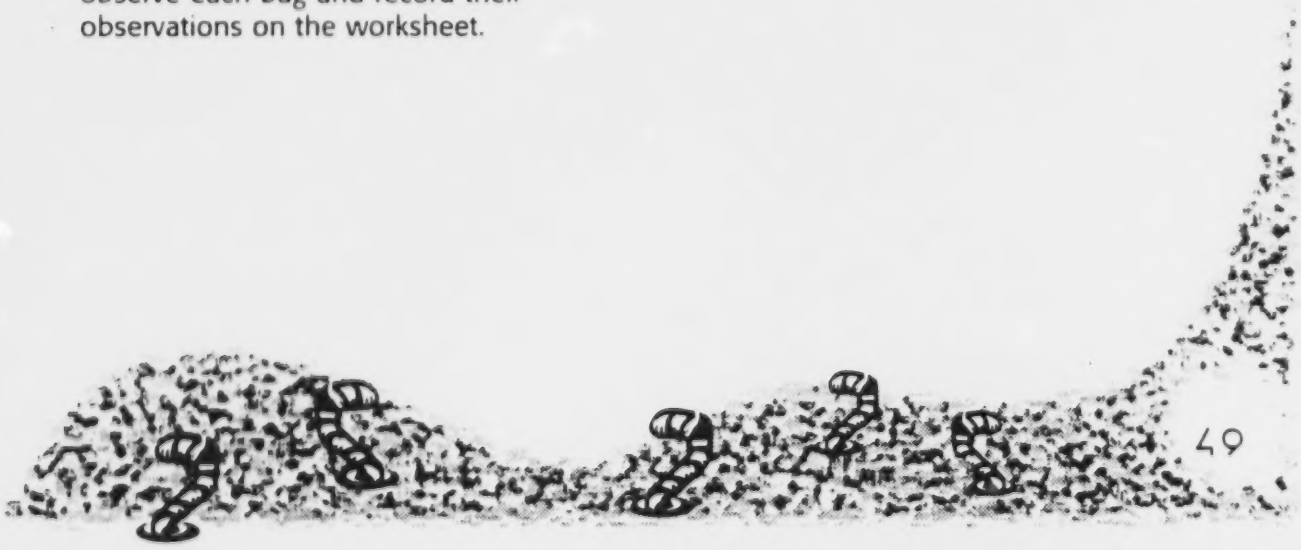
9. The bread and banana should be well on their way to decomposing. Allow the students to observe the structures of mold and the decomposition of the bananas with a hand lens. Students can draw what they see on their worksheet, or on separate sheets of paper. What has the yeast done to the banana? What role does moisture play?

Note: The oranges or lemons may take a week or longer to turn into bluish-green fuzz balls. If so, continue the experiment an extra week.

**Extension**

Bake yeast bread. The yeast are fungi that are alive. The fungi eat the honey or molasses in the dough and give off carbon dioxide as a by-product. The carbon dioxide gets trapped in the net of gluten fibers and causes the dough to rise.

Source: Alameda County Home Compost Education Program, 7977 Capwell Drive, Oakland, CA 94621, (510) 635-6275



# Fungi And Bacteria

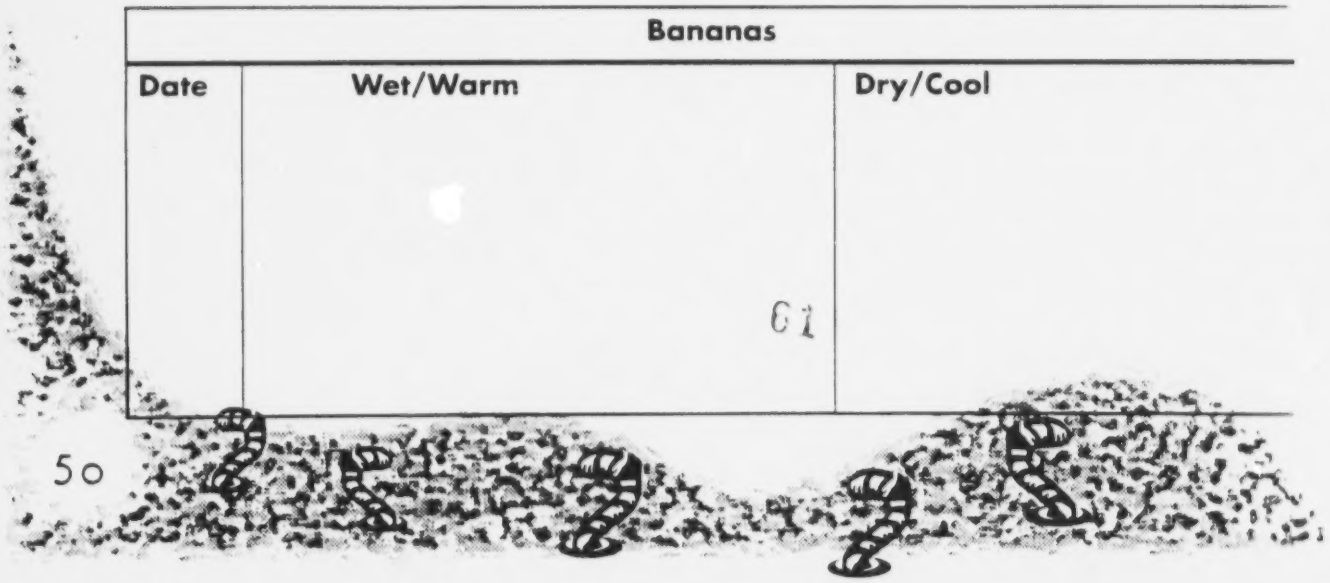
Name _____

**Worksheet**

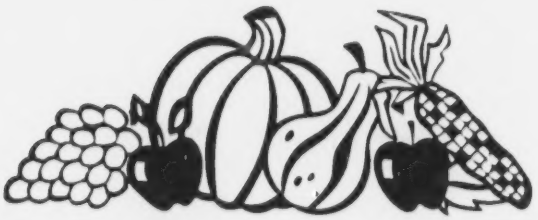
| Bread | | |
|---|---|---|
| **Date** | **Wet/Warm** | **Dry/Cool** |
| | | |

| Oranges/Lemons | | |
|---|---|---|
| **Date** | **Wet/Warm** | **Dry/Cool** |
| | | |

| Bananas | | |
|---|---|---|
| **Date** | **Wet/Warm** | **Dry/Cool** |
| | | |



# Skin Deep



**Description**

Students bury fruit cut into different size pieces in either a worm compost or a backyard compost bin and record decomposition rates.

**Objective**

Students will see that cutting up organic material speeds decomposition by creating more surface area for decomposers to feed on. Students will see how skin acts as a protective covering to keep microorganisms out.

**Grade**

2-8

**Time**

Ongoing project

**Materials**

- Four whole fruits of the same type (e.g., four apples, melons, or tomatoes)
- A cutting knife
- A compost system to bury the food in (if you do not have a compost system, food can be buried 10 inches in fertile soil)
- Popsicle sticks
- Journals

**Procedure**

1. Use one corner of your compost bin to bury the food.
2. Prepare the four pieces of fruit: leave one intact with the skin unbroken, puncture the skin of one with a knife, cut one in fourths, and chop the last one into many small pieces.
3. Bury each of the fruits in the compost or the ground and mark with a labeled popsicle stick.
4. Dig up and check weekly.
5. Record the rate at which each fruit is decomposing in relation to the amount of surface area available for decomposers to feed off of.
6. Record where the decomposition has started and what part of the fruit it is spreading to.

**Extension**

Graph the relationship between the number of pieces the fruit was cut into, and how many weeks it took to completely decompose. Repeat the experiment with another type of fruit and compare results. Find examples in nature of the same materials decomposing at

different rates due to differences in surface area.

**Discussion**

Which would decompose faster, a 200-pound log or 200 pounds of small twigs? In what situations would it be reasonable to buy large expensive equipment and use fossil fuels to chop organic materials into smaller pieces? What was the difference between the fruit with the skin intact and the one with a puncture in the skin? How does skin act as a protective covering? When humans get a cut why should they clean it and cover it as soon as possible?

Source: Marin County Office of Waste Management, 3501 Civic Center Drive, Room 403, San Rafael, CA 94903, (415) 499-6647

# Dirt for Lunch

### Description

Students track the food in their lunches back to the earth.

### Objective

To illustrate that all our food comes from the earth and that healthy food depends on healthy soil.

### Grade

2-6

### Time

One class period

### Background Information

Many children do not understand that all of our food including animal products and processed foods originates from the earth's soil. Soil is made up of five components: sand, silt, clay, organic material, and soil organisms. Different soil types have different proportions of these components. In general, soils high in organic material house large numbers of soil organisms and are very fertile. Soil organisms are classified as decomposers since they eat dead organic material. Organic material is anything composed of or derived from living organisms. There are many decomposers. Some we can see like worms, sow bugs, and beetles, but most, like bacteria and fungi, are too small for our eyes. A tablespoon of healthy soil can contain many billions of bacteria and fungi.

### Materials

Students' lunches

### Journals

### Procedure

1. In their journals, have students list everything they are having for lunch.
2. Inform students that no matter what they have packed for lunch, ultimately they are eating dirt.
3. Challenge students to name a food in their lunches that did not come from dirt.
4. Help students figure out the ingredients in different foods and, as a class, trace each food's origin back to the earth.
5. Use a tuna fish sandwich for an example.

The bread came from wheat grown in the dirt.

Pickles are preserved cucumbers grown in the dirt.

Lettuce was grown in the dirt.

Mayonnaise came from eggs, that came from chickens, that ate grains grown in the dirt.

Tuna living in the ocean eat smaller fish that eat zooplankton that eat phytoplankton, which need nutrients from the decomposed bodies of dead plants and animals accumulated on the ocean floor and brought to the surface by currents.

**Extension**

Make posters and pins that say, "I Eat Dirt, Ask Me How."

Source: Marin County Office of Waste Management, 3501 Civic Center Drive, Room 403, San Rafael, CA 94903

(415) 499-6647

# Growing Plants With Compost

## Description

An experiment to observe how plants germinate and grow with varying amounts of compost.

## Objective

To see if adding compost to the soil has an effect on the sprouting of seeds and the growth of plants.

## Grade

2-8

## Time

Ongoing project

## Background Information

Adding compost to the soil can increase the soil's ability to hold water. In addition, compost can add nutrients to the soil. This helps the plants in your garden to grow. On the other hand, it is difficult for seeds to sprout in pure compost. In fact, sensitive seeds may even be killed by a fungus if you try to sprout them in compost. This problem occurs most often when the organic material is not completely broken down.

## Materials

Four flower pots or cups with drainage holes

Gravel for drainage

Compost

Perlite

Seeds (bean, pea, radish, or lettuce seeds work well)

"Growing Plants With Compost Record"

Pencil

Scraps of paper or cardboard

## Procedure

1. Put 1 inch (2.5 cm) of gravel in the bottom of each of the flower pots. Label the pots 1 to 4.
2. Fill pot 1 with 100 percent compost
3. Using a measuring cup or other plastic cup, measure part compost and an equal amount of perlite. Mix

the compost and perlite together thoroughly. Fill pot 2 with this 1 to 1 compost-to-perlite mixture.

4. Using a measuring cup or other plastic cup, measure one part compost and three parts perlite. Mix the compost and perlite together thoroughly. Fill pot 3 with this 1 to 3 compost-to-perlite mixture.

5. Fill pot 4 with 100 percent perlite.

6. Plant three to four seeds of the same species in each pot. Bean seeds are fast growing and easy to observe.

7. Water your seeds following the instructions on the package. Make sure you add the same amount of water to each pot.

8. After four or five days, your seeds should have sprouted. Count the number of seeds that have sprouted in each of the four pots. Record the number of seeds that have sprouted. Thin the extra plants so you have one plant in each pot.

9. Follow the growth of your plants for four to five weeks. Once a week, measure the height of the plant in each pot. Record the height of the plants. Note if any plants die.

10. After five weeks, count the number of surviving plants. Compare the number of surviving plants in the different mixtures of compost and perlite. Then measure the height of the plants.

Note: To be more scientific, you may want to have more than one pot for each of the four compost "treatments."

**Extensions**

Repeat the experiment with a different kind of compost (vermicompost or backyard compost) and note any differences.

This experiment can also be done in a garden bed by mixing different measured amounts of compost into the soil and planting the same seeds in each bed.

Source: A Cornell Cooperative Extension Publication, *Composting: Waste to Resources,* Cornell University, Ithaca, NY, 14850, (607) 255-5830

# Growing Plants With Compost

Plant species: _____

Date planted: _____

Sprouting pot number: _____

Plant: _____

Date: _____

**Number of Seeds Sprouted**

1

2

3

4

---

**Growth Pot Number**

Date_____ Height_____

Date_____ Height_____

Date_____ Height_____

Date_____ Height_____

**Growth Pot Number** _____

Date_____ Height_____

Date_____ Height_____

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**Growth Pot Number** _____

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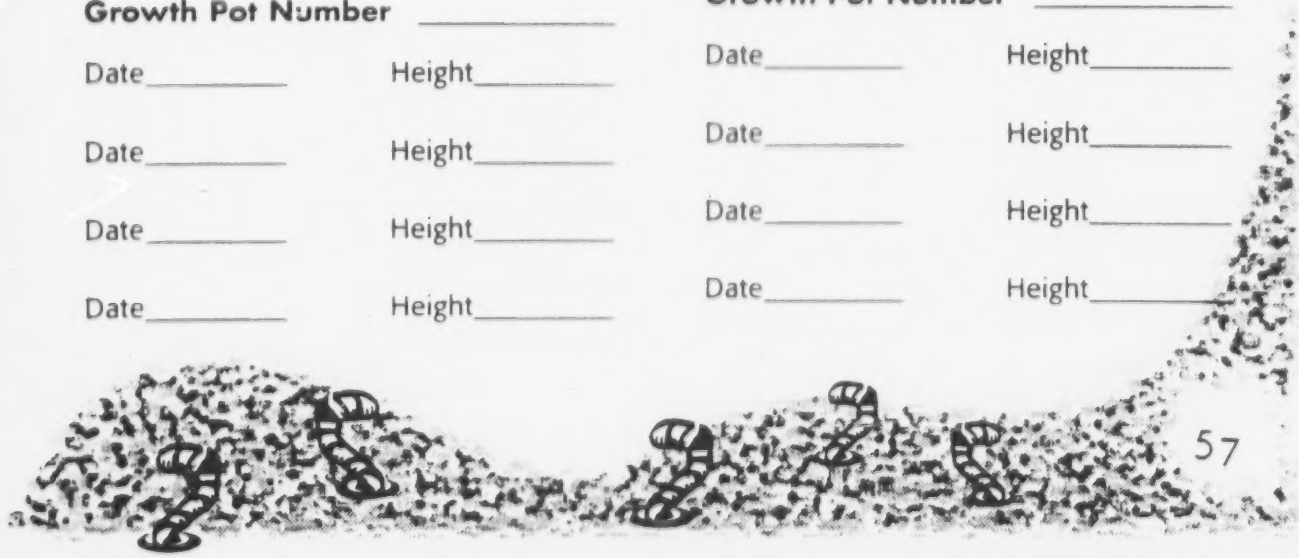


# Decomposer Tag

**Description**

Students play a freeze tag game where death tries to tag and freeze the nutrients in plants and animals. The decomposers unfreeze the nutrients trapped in dead bodies, allowing them to return to the cycle of life.

**Grade:** 2-6

**Time:** 20-30 minutes

**Materials:** Two light colored and one dark colored bandanas.

**Procedure**

1. One student is "Death" and wears a dark colored bandana.
2. Two or three students are decomposers and wear light colored bandanas. All other students are plants or animals.
3. Death kills plants and animals by tagging them. If plants or animals are tagged, they are frozen in place until one of the decomposers unfreezes them by running around them three times. The decomposers unfreeze the plants and animals as fast or faster than death freezes them.
4. The game has no natural end. You should let students play long enough to experience the concept, and stop the game well before students get exhausted and/or lose interest.

**Variation**

To demonstrate that life would stop without decomposers recycling dead things, you can allow "Death" to tag and freeze the "Decomposers" along with the plants and animals. The game, and life on Earth, ends when everyone is frozen except "Death."

Source: Marin County Office of Waste Management, 3501 Civic Center Drive, Room 403, San Rafael, CA 94903 (415) 499-6647

# I Can Compost...

**Description**

In this game students call out something they can compost before the person in the middle tags them. This game can be played indoors or outdoors.

**Objective**

Students review what they can compost.

**Grade**

1-8

**Time**

20 minutes

**Materials**

A ball or other object to toss.

**Procedure**

1. On the board or in their journals, students list as many items as possible to compost.
2. To start the game everyone stands or sits (if indoors) in a circle.
3. A person calls out something that can be composted and the person's name who the Koosh ball (or any other appropriate object) is being tossed to.
4. Once students get the hang of it, put someone in the middle of the circle, whose goal is to tag the person with the ball before it is tossed. If tagged, that person changes places with the one in the middle.
5. To make sure all the students get a turn, students can sit down after they have named something they can compost and tossed the ball to another student.

**Extension**

A song, rap, or poem can be created out of the list of what can be composted.

Source: Marin County Office of Waste Management, 3501 Civic Center Drive, Room 403, San Rafael, CA 94903 (415) 499-6647

# Nobody Likes Me

Nobody likes me, Evrybody hates me,

Guess I'll go eat worms, Long, thin, slimy ones,

Short, fat, juic-y ones, Itsy-bitsy, fuzzy-wuzzy worms.

2. Down goes the first one,
   Down goes the second one,
   Oh, how they wiggle and squirm,
   Long, thin, slimy ones,
   Short, fat, juicy ones,
   Itsy-bitsy, fuzzy-wuzzy worms.

3. Up comes the first one,
   Up comes the second one,
   Oh, how they wiggle and squirm,
   Long, thin, slimy ones,
   Short, fat, juicy ones,
   Itsy-bitsy, fuzzy-wuzzy worms.

**Pill Bug or Roly Poly**

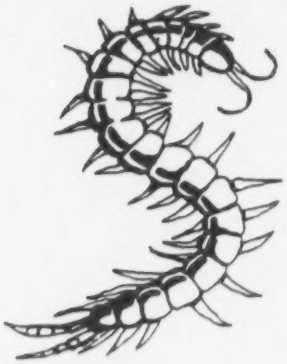
I am an isopod, which means I have 10 pairs of legs that look very similar to each other. I eat old leaves and other stuff like veggie scraps. I am about 1/2 inch long and I roll up in a ball if I am disturbed. Some people think that I look like a little armadillo. I am a greyish, dark color.

**Ant**

I am an insect with six legs. I help to decompose by breaking materials into smaller particles. I create tunnels and move soil into clumps. Some people would rather not have me around their homes. I am black, brown, or red.

**Earthworm**

I am a long, thin soft-bodied animal. My body is made up of little segments. I do not have legs or eyes. I sense light and I breath through my skin. I eat bacteria, fungi, and decaying materials. I like dark, moist places.



**Centipede**

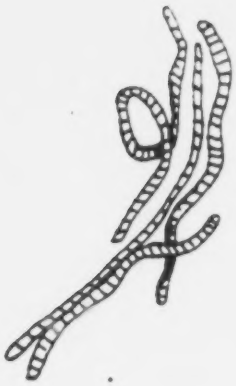
I move quickly on my many legs. I have 15-137 segments with a pair of legs on each. I am a fierce hunter. I love to eat earthworms. I use my pair of poison claws to help keep my prey from getting away. I am about 1 to 2 inches long. I am usually reddish brown.

**Sow Bug**

I have 10 pairs of legs. That makes me an isopod like my cousin the Roly Poly. I eat vegetation and old leaves. My 1/2-inch body is oval and flat with flattened plates but I can't roll up into a ball like Roly Poly. I am related to crayfish and lobsters. I breathe with gills, so I must live in a damp, moist place. I am a dark, greyish color.

**Fruit Fly**

I am a very small fly. People don't like me but I don't bite, sting, or make buzzing sounds. I don't harm earthworms either. Sometimes you will see me around a worm bin if a person forgot to bury their food. I like to lay my eggs where it's moist and warm.



**White Worm**

I look like a frayed piece of thread. I am a skinny, white worm. I am about an inch long. I am related to the earthworm. I like to eat rotting food after the other critters get to it. You might think of me as one who likes to finish off the job.

**Bacteria**

I am so tiny that you can't even see me. I am colorless. I can eat almost anything. Some of us live together in groups and others don't. We are everywhere.

**Mold**

I am a fungus. I am related to mushrooms. Most of us live on old food such as cheese. You might see me on old food in your home or your worm bin.

**Slug**

I have muscular discs on my underside that are adapted for creeping and crawling. I lay egg masses that look like jello. I eat living material but will make an appearance from time to time in your compost pile to eat fresh garbage and garden trimmings.

**Mite**

I am tiny. It would take 25 of us to cover an inch-long line. My body is round and fat so it's hard to see my eight legs. I eat plant materials such as mold and soft tissues of leaves. Some of us eat the manure of other organisms. I am usually white or brown.

**Millipede**

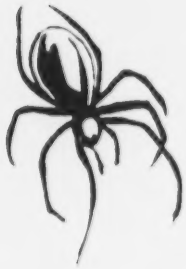
I have so many legs you would have a hard time counting them. My name means "thousand legs," but I don't have that many. I am very shy and I roll up in a ball to avoid danger. I am a vegetarian and eat soft, moist, decaying plants. I am dark-red in color and am 1 to 3 inches long.

**Springtail**

I am a tiny insect less than 1/16 inch long. I eat molds and decaying materials. I have a little spring that helps me jump high into the air. I am white.

**Beetle**

I am an insect with shiny, black, tough wings and am about 1/2 inch long. I am a predator and eat slugs, snails, and soft insects such as caterpillars. I live beneath stones, boards, and in other moist places.

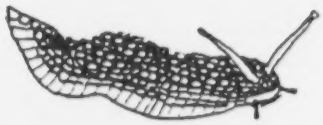


**Spider**

I am related to mites and have 8 nifty legs. I am one of the least appreciated animals in the garden and compost. I feed on other insects and work hard to help control pests that will hurt a garden.

**Collembola**

I am a close relative of the springtail but I can't jump. I am tiny, and less than 1/16 of an inch long. I eat molds and decaying matter. I am white in color.



**Snail**

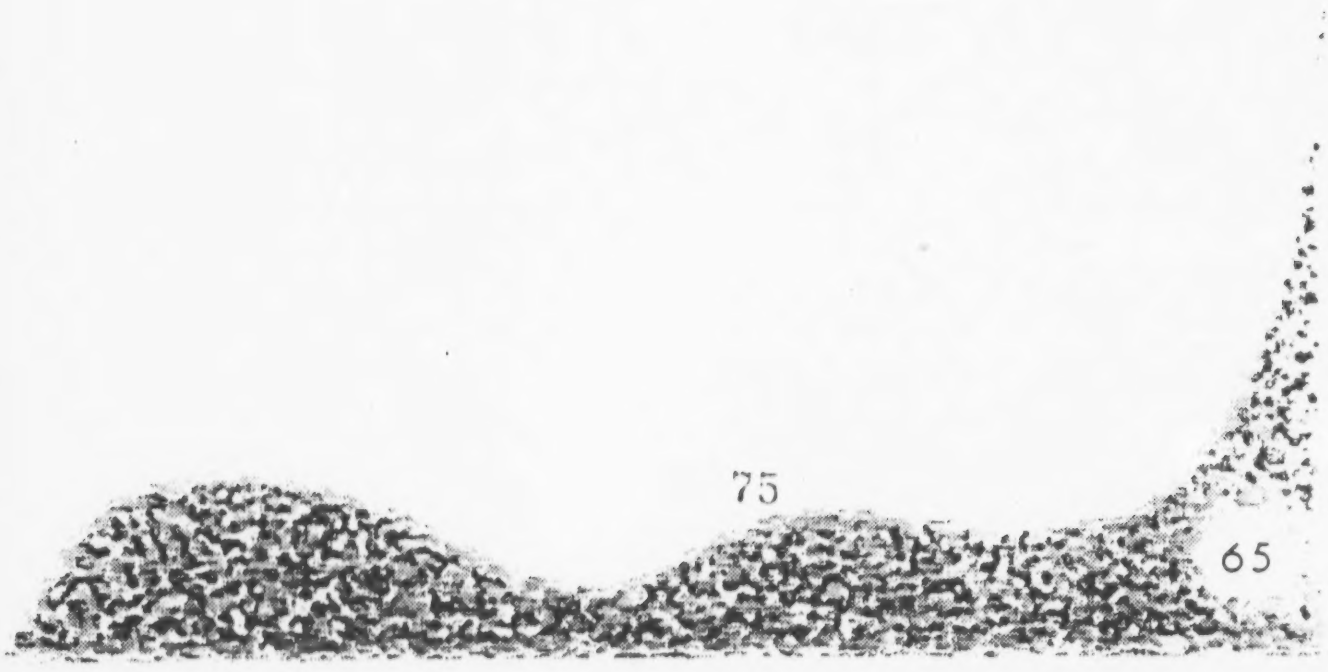
Like my friend the slug, I am a mollusk and creep around on my muscular belly. I, however, carry on my back a spirally curved shell. I also have a broad retractable hood and a distinct head. Like slugs, I prefer to eat living material, like leaves, but I will also show up in your compost pile or worm box from time to time for lunch.

**Worm Cocoon**

You can find me in a worm bin or a compost pile. Before I have hatched I am clear and yellowish and the shape of a lemon. After I have hatched I turn pea green. Two or more baby worms are hatched at once.

Source: Alameda County Home Compost Education Program, 7977 Capwell Drive, Oakland, CA., 94621, (510) 635-6275.

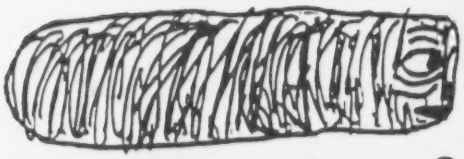
# Case Studies on Vermicomposting



# CASE STUDY - 1

# PACIFIC UNION ELEMENTARY

# Worms, Worms, And More Worms!



## Mr. Triskas' 4th Grade Vermiculture Project

## Acknowledgements

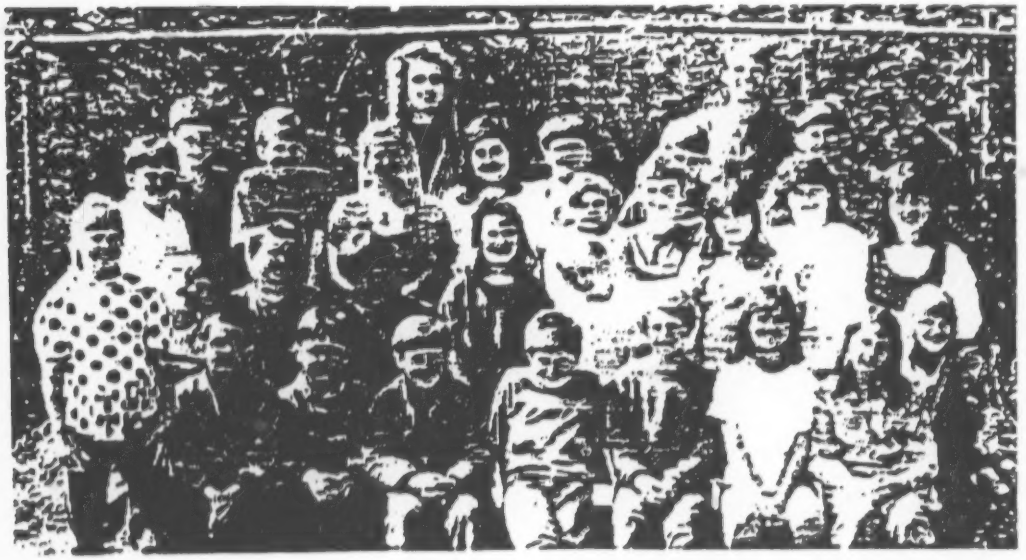
This book is the result of many, many fingers in the bin. For starters, I'd like to thank Mary Lou Cook of the Waste Education Project for inspiring the very idea of forth grade vermicomposting studies, Dr. Doris ("Just do it!") Niles and Peggy Shoop for their support at the inception, and Tim and Peggy Matthews of the Redwood Valley Worm Farm for bringing live, wriggling worms into our classroom.

Thanks also to Cindi and Larry and the kids at Equinox School for having us over to observe a working worm bin in action. And to our friends at Humboldt State's Campus Center for Appropriate Technology who first modeled worm bins for us, we are much obliged. Also, we are indebted to the forward-thinking Pacific Union Parent Association and Adventure Garden Committee for helping to fund the worm bin that now turns kitchen scraps into gold in our garden here at school.

My appreciation goes to the parents of this year's class who never once questioned the dank smell of earth and decomposition in our classroom at Back to School Night, supporting me in my belief that active, discovery science is so much more valuable than tidy, sanitary classrooms. Thank you so much, Kimberly Childers, columnist, gardener, artist, and most importantly, my teaching assistant, for everything, everyday! And finally, I am most grateful to the children that scalped the first worms, hunted down the tiniest cocoons, and celebrated every minute hatchling in their bins. Sharing their enthusiasm and wonder has awakened in me again some of the simplest joys of my own childhood.

J. Triska
March 28, 1994

Thanks to Pacific Union School



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In Humboldt County, more food waste is sent to the landfill than any other single item except wood waste ash. The County's 1990 Waste Generation Study estimated more than 13,000 tons per year of food waste disposed of at the Cummings Road landfill (7.64%), with an additional 3,400 tons being diverted for use as livestock feed and by-products.

By comparison, only 1200 tons of old tires, 7,900 tons of all plastics, and 8,400 tons of leaves, grass and prunings were disposed of during the same period of time.

As you well know, food waste is a leading contributor to the amount of waste material produced by schools, second only to paper. Although much of the paper is reusable and recyclable, and is accepted by recyclers throughout the county, food waste must usually be dealt with on-site, as collection and centralized processing does not yet exist in this county, and might be prohibitively expensive as well.

Vermicomposting, composting with worms, provides an excellent opportunity to involve students in a truly "hands-on" learning experience which will help to reduce the amount of foodwaste sent to the landfill, while teaching students about the fascinating world which exists in the dirt. Probably most suitable for students still young enough to like dirt, and for teachers who don't mind it, we hope that you will find the adventures of the fourth grade class at Pacific Union as interesting as we have.

In the back of this book, you will find a coupon for $5 towards the purchase of your first worms. This coupon may be redeemed at Solutions in Arcata, at Tim and Peggy Matthews' Redwood Valley Worm Farm (Redwood Valley), or at Fox Farm Fertilizer and Soil Amendments in Trinidad.

We thank you for your interest in helping students to learn more about the world in which they live.

Liz Citrino 441-2005 923-3805
Humboldt County Waste Prevention Coordinator

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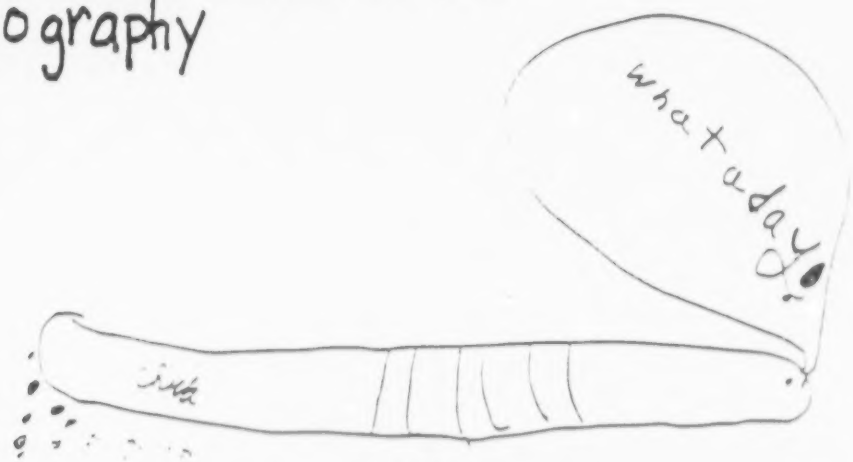
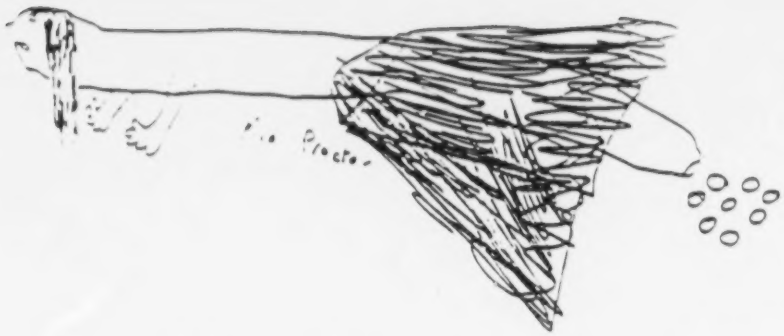




# Why Raise Worms?

By Katrina Shannon, Mia Proctor, and Nicole Frint

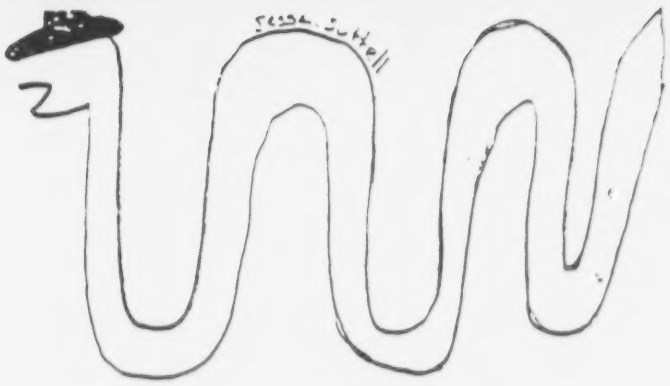
People raise worms for many reasons. First of all, people feed their kitchen scraps and leftovers to worms so that they aren't wasting food. By feeding their worms, people keep some of their garbage from going to the landfills, which are already too full.

Second, worms are good for your garden or house plants. Their castings make excellent fertilizer. Castings are really worm poop. Worms eat your garbage and make poop that provides nutrients that plants need. Nurseries sell worm castings by the pound, but they are very expensive. By raising worms, you can get the best possible fertilizer free.

Some people like to raise worms for fishing, or to sell to others for fishing bait.

Others like the hobby of raising worms, the way some people enjoy fish aquariums or other pets.

Whatever their reasons, many people are having fun learning more about vermiculture: raising worms.



# The Adventure Garden Worm Bin

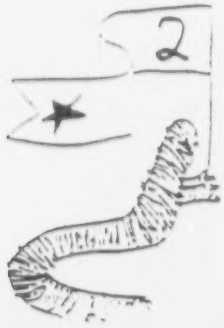
By Richard Rutherford, Joseph Arispe, and Aaron Aguilar

To make our worm bin we first cut and painted our wood. The paint keeps the wood from rotting. But it can only have paint on the outside of the bin because paint is poisonous to the worms. We put chicken wire underneath the bin so gophers and moles can't get in. We put lids on top with latches to keep raccons from getting into our garbage. We filled it with composted leaves, hay, and grass clippings. Then we added the worms.

Our bin is divided into three sections: an active side and two resiting sides. In the active side, worms live and are eating the vegetable and fruit scraps from the cafeteria kitchen. The worms move to the active side because they are hungry. The resting sections of the bin are where we used to pile the food scraps. Since we are putting them in the new active side, the worms have moved over there. Now we can take out the castings that they have left behind.

In our class we take turns going to the kitchen to pick up the food scraps. The cooks collect them for us in a big white bucket that says, "Worm Food". We take the bucket to the garden and dump it into the active side of the worm bin. We rinse out the bucket and return it to the cooks.

The two main reasons we have the worm bin are so the landfill doesn't get filled up so fast, and so we can make worm castings for our garden.





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# Our Small Group Bins in the Classroom

By Alisha Gimenez, Jaime Cortez, and David Bobillot

When we first began learning about worms, we experimented with different kinds of conditions to find out what worked best.

To make our experimental bins we got small plastic bins with lids from the Dollar Store. We drilled holes in the sides, tops, and bottoms so the worms could breathe and the scraps would not rot. We covered some of them with black construction paper with holes poked in it to make the bins dark, because light is painful to worms and will kill them.

Our most successful bins had babies being born, and healthy worms. These bins got enough food but not too much, were kept moist but not wet, had the food and moisture mixed in everywhere, and were completely dark.

Unsuccessful bins had fewer babies being born, and in some bins most worms died. They were either too wet or too dry, had too much hay and not enough other foods, and got too much light.

# The Story of Our Big Classroom Bin

By Jon Jennings, Chelsea Rose, and Tiffany Taylor

Once there was a big blue bin that contained many, many worms. But let's travel back in time because we want to tell you a story about the bin. All right. Here we are. See that bin? That's the master bin. It's big and blue. And see those other ones? They are what the kids call "black with construction paper". We prepared them for when Tim and Peggy Matthews came to give us our worms.

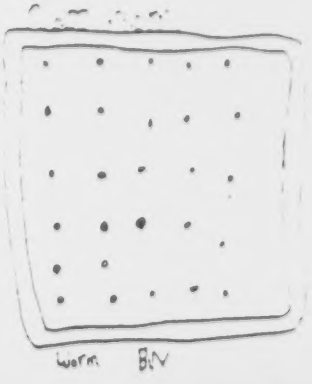
The worms probably thought they were moving, so they felt OK. But we don't know. We're just Jon, Tiffany, and Chelsea, your average students. We're not mind readers or anything.

Anyway, as we were saying, the Matthews thought it was OK because we were buying them from them. After they came into our classroom they sat down and gave us a big lecture about how to take care of the worms, and how they are photosensitive to light. That's a big word: pho-to-sen-si-tive. It means that light hurts them when it touches them.

Anyway, we got an ounce of worms in each of the kid bins. And the big bin had over ONE THOUSAND worms. That's a ton of worms. Actually, that wouldn't be a ton. It would be about 12 ounces, but still, that's a lot of worms.

The worms liked their new home and so had no reason to leave. But then a food shortage came along and one worm after another began to leave. We found them in a big circle, all dried up, around the big blue bin. When we counted them, we found only a few worms still in the bin! We called this "The Great Worm Escape." Hopefully, some of them made it into one of our other small bins.

So when you build a worm bin, remember: feed your worms! This is Jon, Chelsea, and Tiffany signing off. Have fun with your new bin!

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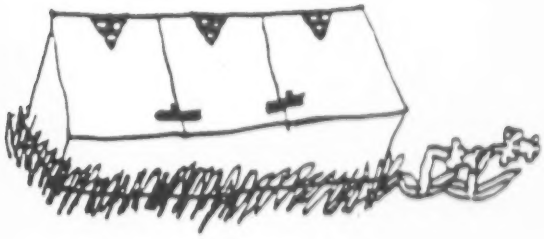


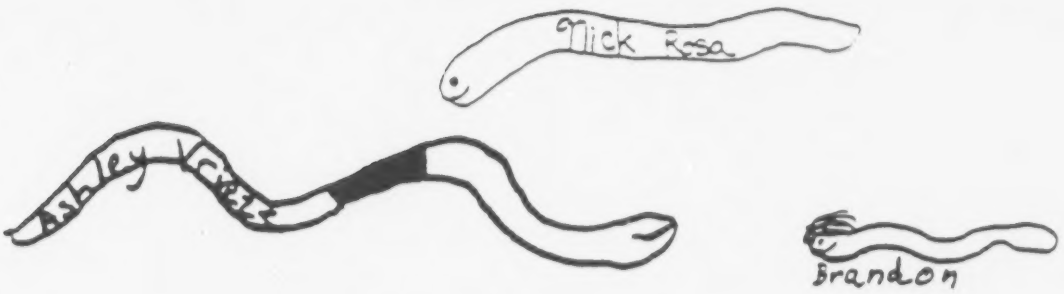
# Making A Garden Worm Bin

By Raemi Manning

To make an outdoor bin for your home garden you need four sturdy pieces of wood for the sides of the box, about 12 inches tall. To make a square bin, they should all be the same length, about two or three feet long. Get 1/2 inch hardware cloth or chicken wire to put under the box to keep moles from getting in. Make a top which you can open and close with hinges. Also put a latch on the lid of the box to prevent animals like racoons from getting in.

The bedding for the box can be lawn clippings, shredded newspaper, or other fine compost from your compost pile. You'll need to add more bedding from time to time, since the worms eat it, too. They need fresh bedding to stay healthy.

Finally, put your worms and your food scraps in the bin!




# How to Make an Indoor/Garage/Patio Bin and Take Care of It

By Nick Rosa, Ashley Vrieze, and Brandon McAdam

If you want to stay inside and save the environment, this is the project for you. The first step is to get a rubbermaid-style storage box with a lid. It should be about 18" x 12" (9" deep). Drill plenty of 1/2" air holes in the sides and top of the bin.

The second step is to buy some 1/8" hardware cloth (screen) to lay along the sides of the bin to keep the bedding from falling through.

The third step is putting in bedding for the worms to live in, which can be shredded newspaper or computer paper, or grass clippings or alfalfa hay. The bedding will need to be moistened well before putting in your worms. Since it's inside, check that it is kept moist with a spray bottle. Add new bedding as it get eaten up.

You can keep your bin under the sink, in the garage, or on a covered patio. Put your food scraps right in it, or save them in a container at the sink until you have enough to put in. Each time you bury your scraps in the bin, put them in a new place. When the bin is all filled up on one side, move the scraps to the other side. You can think of the places in the bin as active and inactive. The worms will eat up food in the active sides while you collect rich castings for your house plants from the inactive sides!

# Where to Get Your Worms

By Gabe Nelson

Worms are great composters. So great, that a pound of them costs about $10. But that is plenty for your composting needs--about 2000 worms. A pound of worms can eat 1/2 a pound of kitchen scraps a day.

We bought our worms from Tim and Peggy Matthews, owners of the Redwood Valley Worm Farm. Many people think any kind of worm is good for composting. This isn't true. The earthworms that you dig up in your garden aren't as good as red worms, the kind we bought. You might find red worms in your compost pile, but they might not be the right kind. The best red worm for vermiculture is Lumbricus rubellus.

You can contact the Redwood Valley worm Farm at 1696 Redwood Valley Road, Blue Lake, California 95525. The phone number is (707) 668-5997. You can also get worms from "Solutions" in Arcata. For a handful to get a small bin started, see Mr. Triska in Room 13.

## What to Feed Worms

By Heather Huffman, Daniel Effman, and Chris Cyphers

Feed your worms your raw fruit and vegetable scraps. They can also eat much more. This is a partial list of things to feed your worms:

apple peels and cores
banana peels
cabbage
onion peels
orange peels
celery ends
pear peels and cores
pineapple rind
potato skins
cucumber peels and ends
eggshells
grapefruit peels
tomato skins
turnip leaves
all vegetable scraps
grains
coffee grounds

Dont' feed them:

meat
fish
oily foods
peanut butter
animal products
wrappers
plastics
rubberbands
foil
candy

## How Much to Feed Your Worms

By Jason Lowe and Cheri Ryan

The important thing to remember is this: 2:1. This means worms can eat half of their weight each day. Two ounces of worms can eat one ounce of food daily. A pound of worms can eat 1/2 a pound of food each day. Try not to overfeed your worms.

# Scalping Worms?

By Mr. Triska

Terrible as it sounds, if you want to use your worm castings for your gardening, you must first "scalp" your worms. "Scalping" is the term vermiculturists use to describe separating the worms from their castings.

There are simple ways to scalp your worms. One is to go out on a bright day and lay out some plastic sheeting next to your bin. Carefully dig up your castings and worms and make a pile on the plastic. Since worms don't like light, they will burrow down to the bottom of the pile and get comfy near the plastic. Wait ten minutes and remove the top few inches from your pile-- this is "scalping off" the castings. Put them in a container for later. Now wait another ten minutes, and scalp off the top layer again. Repeat until you have nothing left on the plastic but a writhing mass of worms. Put them back in your bin.

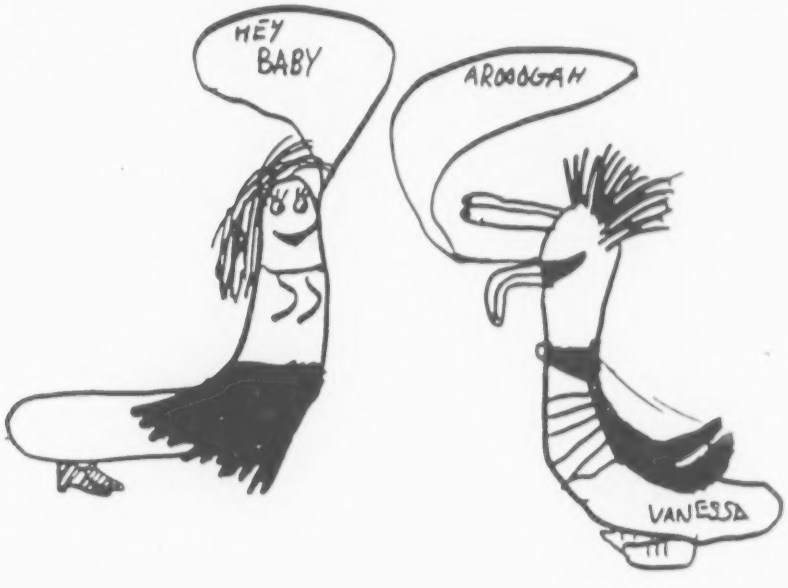
We scalped our big classroom worm bin in a cardboard box with a desk lamp aimed down over it. It worked beautifully. You could use this method for your indoor worm bin.

Another way to get your castings is to have "active" and "inactive" parts of your bin. In our school's Adventure Garden bin which composts Pacific Union's kitchen's scraps, we have three separate lids. One lid is opened to put in fresh scraps, while the other lids are considered inactive. Most of the worms move to the active part to eat the new scraps, leaving behind their castings in the other sections. To harvest the castings, students just lift up the inactive lids and scoop them out.

# The Worm Life Cycle

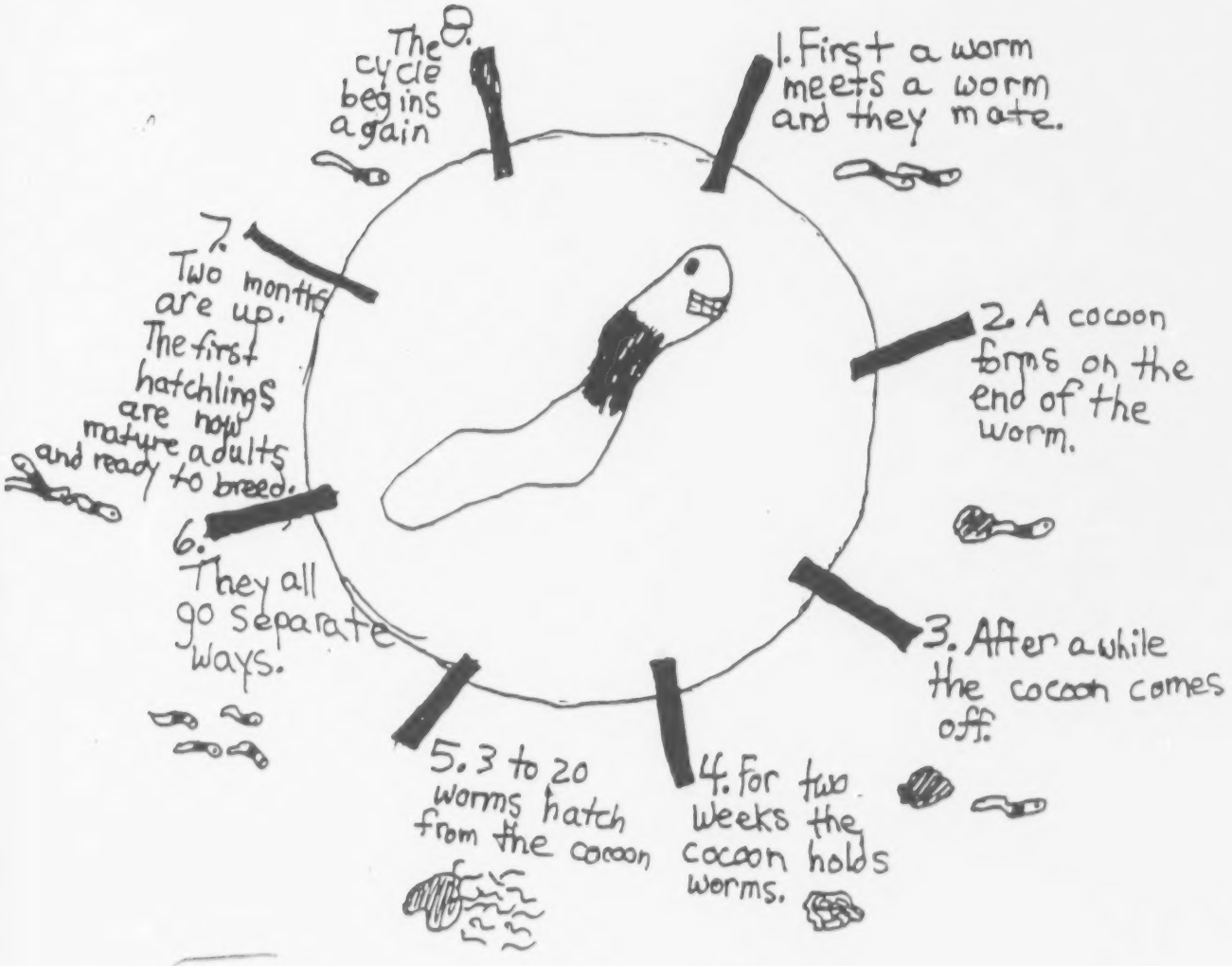
By Matthew Johnson and Vanessa Ericksen

The life cycle of a worm is weird. It's like this. First a worm meets another and they mate. A cocoon forms on the end of the clitellum. After a while the cocoon pops off. For two weeks the cocoon holds worms. Three to twenty worms hatch from the cocoon and all go their separate ways. Two months are up. The first hatchlings, now mature adults, will be ready to breed. Once it breeds and begins laying cocoons, a worm can make two to three cocoons a week for about six months to a year. That's a lot of worms!



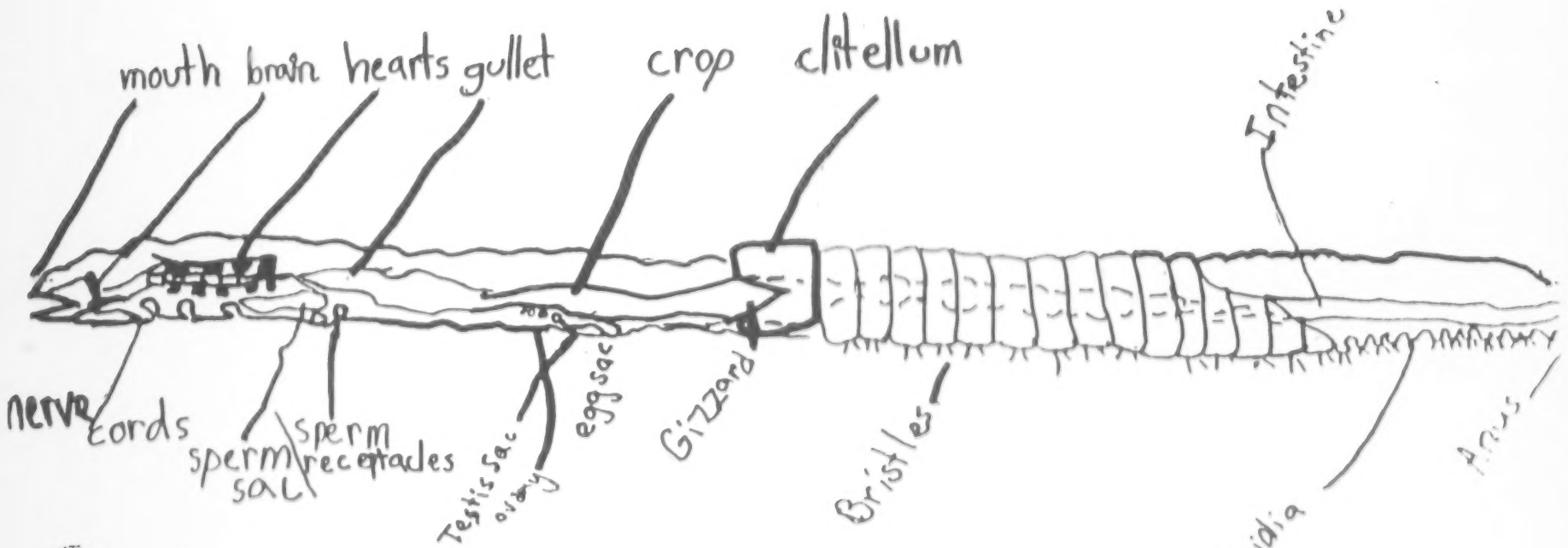
# The Life Cycle of A Worm

By Vanessa Ericksen and Matt Johnson


1. First a worm meets a worm and they mate.
2. A cocoon forms on the end of the worm.
3. After a while the cocoon comes off.
4. For two weeks the cocoon holds worms.
5. 3 to 20 worms hatch from the cocoon
6. They all go separate ways.
7. Two months are up. The first hatchlings are now mature adults and ready to breed.
8. The cycle begins again

Fact: A worm can make three cocoons a week for about six months to a year.

# Diagram of a Worm




by Kaitlyn Howell and Jesse Suttell



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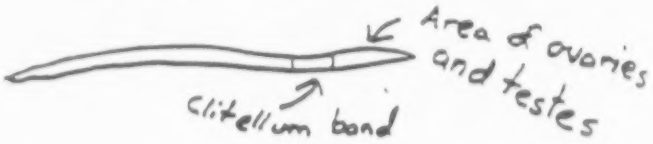
# Mating and Cocoons

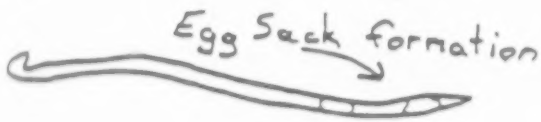
By Geoff Gulbranson

Each worm is both male and female.




Two worms join making a bunch of mucus from their clitella bands. The sperm from each worm gets passed to the other's sperm storage sacks.

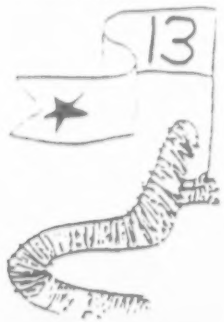
The mucus forms a band around the clitella of each worm. This will become an egg sack. The worms then back themselves out of this hardening egg sack.




Eggs and sperm are put into the egg sack as it passes over the openings of the sperm storage sacks and ovaries.

After the sacks are released from the worms, they close up at both ends. The eggs are fertilized by the sperm inside the eggs.

In about two weeks, two to twenty worms will hatch from each egg sack.

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What Other Creatures Live in the Worm Bin?
By Matthias Darnell

In your outdoor worm bin (and in compost piles generally) you'll have many different creatures besides worms. Some of the organisms help break down the food along with the worms, but others may actually eat your worms. Most just stay in the bin and don't hurt anything.

These, you do want:

molds
bacteria
actinomycetes
sowbugs
earthworms
beetle mites
white worms
land snails and bugs
flies
round worms
millipedes

These, you don't want:

flat worms
ground beetles
predatory mites
pseudoscorpions
centipedes
ants
rove beetles

Of course, your bin will manage itself. You won't need to act on any of this information, unless you want to use all of your spare time identifying and sorting through the critters in your bin. It's just fun to know what's in there.

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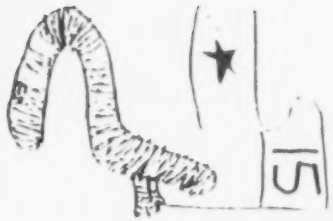

Ground Beetles 8-20mm
PSEUDOSCORPION 1-2 mm
Centipedes 30 mm
PREDATORY Mite 5-1mm
Rove Beetles 10 mm
Ant
5-10mm

SPRING-tails 5-7mm

Moldy Beetle Mite 1mm

Feather-winged Beetles 2mm

Moth

Bacteria

Round worms
PROTOZOA 1-5mm
ROTIFERA 1-8mm

ACTINOMYCETES

ORGANIC RESIDUES

Soil Flatworms 70-150mm

Fly 1-2 mm

Sowbug 10 mm

Round Worms 1 mm
White Worms 10-25mm
Earth Worms 50-150mm
Land Snails and Slugs 2-25
Beetle Mites 1mm
MilliPEDes 20-80mm

Mathias William Darnall



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# Worm Myths and Facts

By Kaitlyn Howell, Jesse Suttell, and Gino Pitino

Q. Why do worms lie dead on the street after a storm?
A. Worms leave the soil because water from rain washes into the dirt and the worms can't breathe in mud. So they crawl out onto the street and sidewalks. They end up in puddles. Now most people think worms drown in the puddles. Actually, if there's enough oxygen in the water, they don't drown. They die because they get too much light. They are photosensitive, which means they are allergic to light. So they really die from the sun.

Q. If you cut a worm in half, will there be two living worms?
A. If a worm is cut in half, the half with a head may grow a new tail, but the tail half can not grow a new head, and so will die.

Q. Will worms hurt your garden by eating your plants?
A. In the old days people thought worms were bad, so they killed them. That's where the word "vermin" came from. But they are really good for your garden. They break down the soil. And your plants will grow more easily. Their castings will help them grow.

Q. Do worms have eyes and noses?
A. Most people think that worms have eyes and noses, but they don't. Yes, that's right, they <u>do not</u> have eyes or noses. The worm has a fleshy pad above his mouth. The pad acts like eyes and a nose since it searches around for food. When it finds food, it brings it in to the mouth and then closes over it.

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# The ABC's of Vermicomposting

A Lumbricus-Lover's Lexicon by Mr. Triska

| | | |
|---|---|---|
| A | aerobic | Earthworms are aerobic organisms, meaning that they use oxygen to carry out life functions. |
| B | bedding | Worms need something to live in. They thrive in a moist, aerated bedding like decomposed leafy matter in nature, or shredded newsprint in your home worm bin. |
| C | castings | Worm castings are great for gardening. They are worm manure ("poop"), really: digested material, soil, and bacteria. |
| D | decomposers | Worms are decomposers-- organisms that break down the cells of dead plants and animals into simpler stuff. |
| E | egg cases | The cocoons of earthworms hold embryonic worms until they hatch. Each egg holds between 3 and 20 tiny wormlings. |
| F | fertilization | Eggs in cocoons are fertilized by sperm cells from the clitellum. Interestingly, worms are both male and female. They are not usually self-mating, however. |
| G | genus | The category of classification for red worms, best for composting garbage, is Lumbricus. The genus is rubellus. Hence, "Lumbricus rubellus." |
| H | humus | An important part of worm castings is humus, which organic gardeners cherish in their soil because it encourages plant growth. |
| I | inoculate | The term used by worm culturists for providing new worms to a bin of bedding to begin the process. |

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| | | |
|---|---|---|
| J | jumbo | Catfishermen prefer jumbos -- extraordinarily large -- nightcrawlers. So commercial worm farmers often fatten their worms by feeding them grain meal. |
| K | kill | What groups of elementary school children do to worms by stepping on them on sidewalks after a rain. Very bad form. |
| L | lime | A calcium compound which helps reduce the acid in worm bins. Crushed egg shells are a good source, and are one of the kitchen scraps you'd be interested in feeding your worms. |
| M | manure worms | Another term for redworms. These are the most commonly grown by commercial worm farmers. |
| N | nightcrawler | These are usually raised or harvested for fishermen; they are <u>not suitable</u> for vermiculture composting because they die in warm temperatures, do not like their bedding disturbed, and need large amounts of soil for their burrowing. |
| O | overload | To deposit more scraps in your worm bin than the worms can keep up with. |
| P | protein | A complex molecule prevalent in meat; for the exotic palate, be advised that worms are 60% protein. Yum, yum. |
| Q | quiet | The perfect adjective for the hobby of vermiculture. Worms will not interrupt your meditation. |
| R | regenerate | A common myth is that a worm cut in half will grow into two worms. (see "Myths and Facts"). They *can* regenerate (replace lost parts) a tail if one is cut off, but <u>not</u> a new head. |
| S | shredded | Shredded newsprint or computer paper makes fine bedding for your worm bin. Worms are not harmed by the inks! |

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| | | |
|---|---|---|
| T | taxonomist | A specialist in classifying organisms, including worms. |
| U | underneath | The preposition signifying where you might find your worms when you are looking for them: *below* the surface of the bedding! They come up only to feed or escape flooding conditions caused by too much water (rain, in nature). |
| V | vermicomposting | The term for composting your kitchen waste through the use of worms and their castings. |
| W | worm:garbage ratio | The ratio for waste-eating redworms is 2:1, or two pounds of worms (2000) to one pound of garbage a day. |
| X | xenophobe | Vermicomposting may not be for the xenophobe, or person who is unduly afraid of strange and unusual ideas and pracuces. |
| Y | yawn | If you fall asleep in your worm bedding, try to keep from yawning: worms are curious and adventurous creatures attracted to dark openings. |
| Z | zygomorphic | Bilaterally symetrical. Many people imagine worms to be zygomorphic, but upon closer examination, see that they are not really (see "Worm Diagram"). That explains why they can't regenerate bilaterally (see "R" above). |

## Worm Observation Guide

Date all entries.
Describe what you see, smell, feel.
Note anything new (eggs, babies?) since last observations.
Draw a sketch of something interesting you observe.
Note any changes you make: adding food, water, changing the worm bin, etc.
Write predictions of what may happen next.
Write down any questions you'd like answered.

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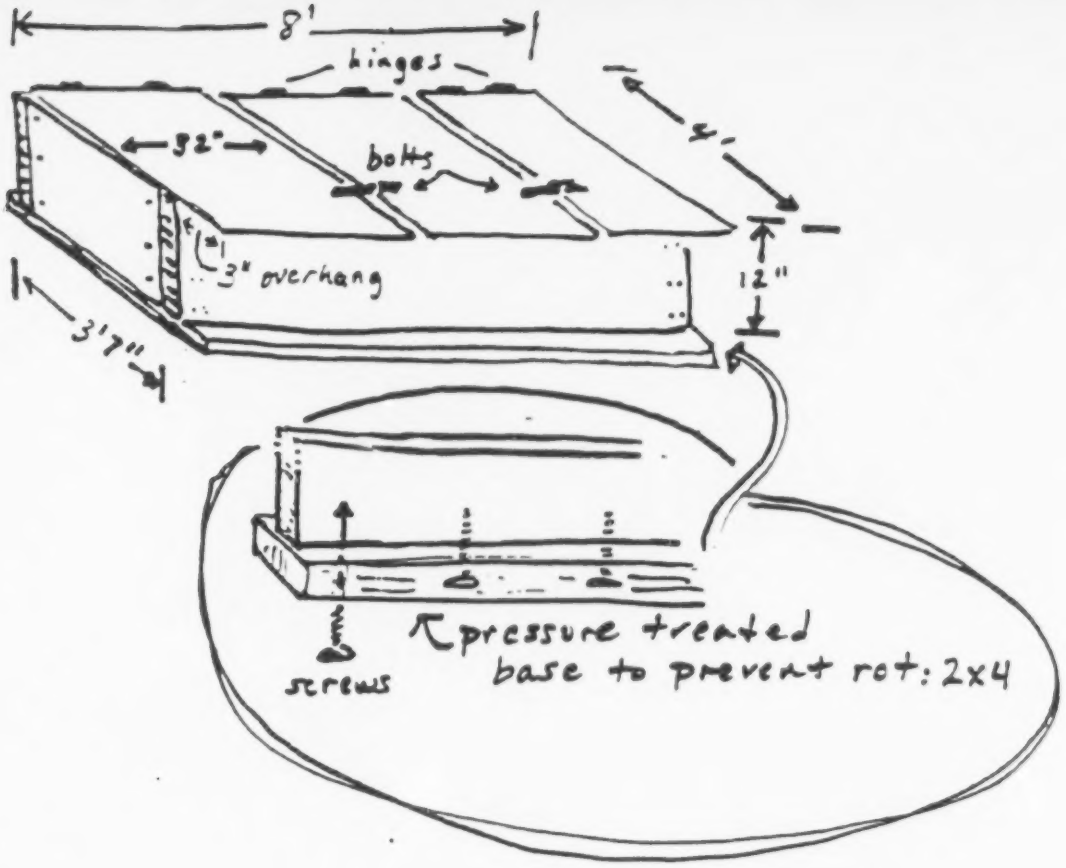


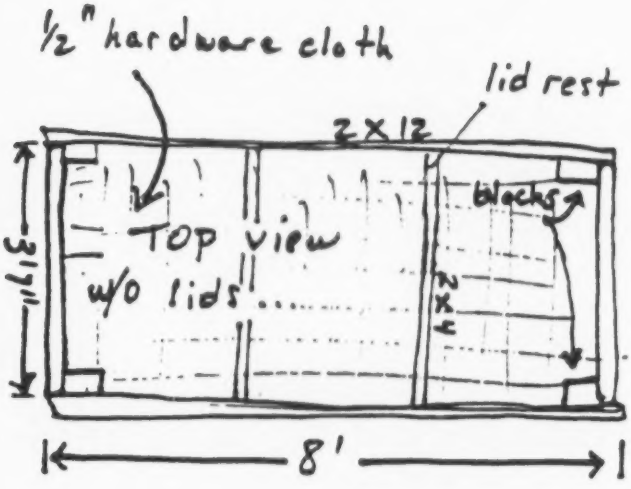

The Pacific Union Adventure Garden Worm Bin
(built in the Fall of 1995 by Mr. Triska's class)

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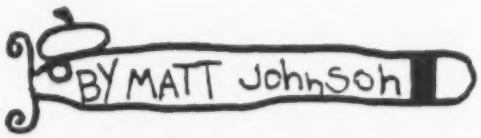


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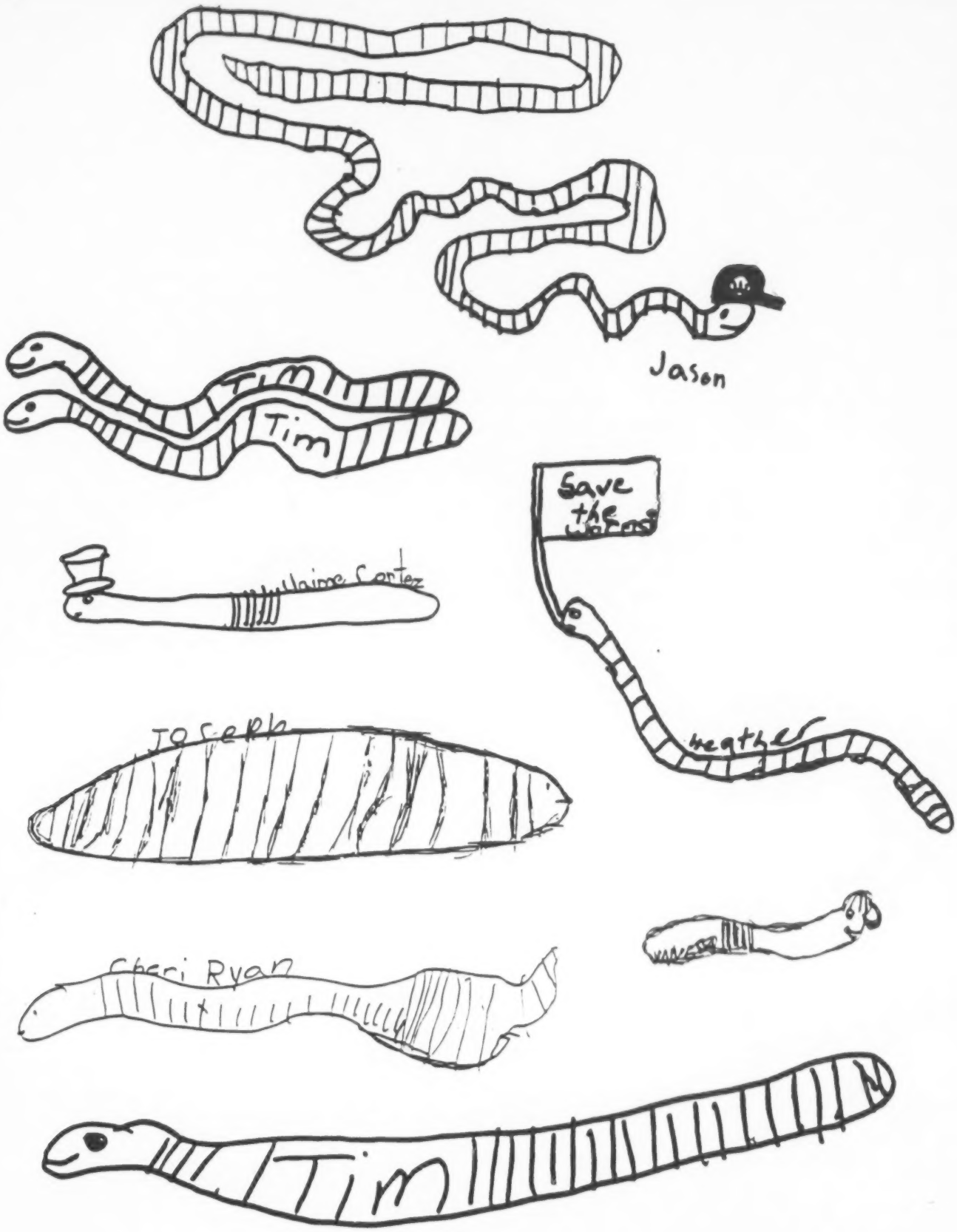
Jason
Tim
Tim
Save the Whales
Jaime Cortez
Joseph
Heather
Cheri Ryan
Tim

# CASE STUDY - 2

# WALTERVILLE ELEMENTARY

CASE STUDY - WALTERVILLE ELEMENTARY SCHOOL

MY BIG LESSON - by Stephen White, Managing Editor, Worm Digest

Excerpted with permission from *Worm Digest*. See Appendix A for ordering information.

In 1994, I was seized by an idea that wouldn't let go. Why not see if I could get a school to vermicompost all of its cafeteria's food waste so I could learn firsthand if and how it could be done. It was a pretty safe bet, as I had already heard Binet Payne speak eloquently about her school's successful garden and worm composting project in Laytonville, California and right here in Eugene, Robert Flow had a 550-student middle school well trained to do the same. At least it was a safe bet that it could be done, but as to how, and what kinds of efforts were going to be required, I was yet to learn. The how I figured would come one step at a time, for as the saying goes, the journey of 1000 miles begins with one step. So I began.

**STEP ONE:** Find a school that is willing. That was relatively easy as Walterville Elementary School, only three miles from where I live, was also the school where my wife Mariya had taught for four years, and, as you probably guessed, she had a worm bin in her classroom for two of those years. In some respects, therefore, it was a shoe-in. After presenting my first written proposal to the principal it was less than two weeks before conditional approval was received. But, before I go too much further I need to tell you that the proposal wasn't for a worm bin project, but for a community-school organic garden. As I look back on that proposal, I chuckle to see that worm composting wasn't even mentioned, except in a somewhat veiled phrase under goals: "To provide an on-site use for the compost created by composting the school's cafeteria food waste." My hidden agenda didn't actually surface until the garden proposal was approved at which time it wormed its way to the surface in a full explanation of what I indeed saw between the table and the garden.

**STEP TWO:** Rally community support. I knew I didn't want to attempt this alone. With connections I already had, having lived in this community for seven years, and with Mariya's connections through the school, a Garden Committee of school parents, other community members and teachers was formed and began having monthly meetings. As the garden idea began to develop under the guidance of the committee, I began to plan my next step in my worm composting agenda.

**STEP THREE:** Organize and design the worm bins. Since school was quickly coming to a close, I felt it was essential to get the worm bins built and set up before summer. That way, the worm populations could be built up (grown) over the summer and be ready to receive the school's cafeteria food waste in the fall. I invited the 4th grade students to join in the bin building fun. They were generally enthusiastic, if for no other reason than it got them out of the classroom. Being quite close to school's end, perhaps even the teachers were thankful. Since we were building five bins (See

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Worm Bin Calculations at the end the classes were divided into five groups. Of course, two groups were all girls, two were all boys, and one, in spite of the general feeling at that age, chose to be a mixed group. They named their groups, "Laser Worms," "Wiggle Working Women," "Wild Worms," "Fried Worms" and "Compost Pile." This added not only to the camaraderie but also a bit to the competitiveness. You can imagine how proud the girls were when I told them they were better at hammering nails than the boys, and they let them know it.

Because we were on a fast track and I didn't have much time to do research, I designed the bins myself. And, since we were as yet unfunded, the materials were donated by parents and local businesses (Weyerhaueser and Jerry's Home Improvement).

**STEP FOUR:** Build the worm bins and create bedding. This step involved my coming to school twice a week for one to one and one half hours initially, but, as school's end swiftly approached, ended up being each day. By the time we had the Garden dedication ceremony on the last day of school, the five bins had been painted a dark green and lined up, sitting on concrete blocks, in their approved site at the edge of the school grounds.

As an experiment we put different beddings in each bin. Shredded newspaper, which the students easily provided, went into two, pulverized cardboard into another, old corn silage for the fourth and composted horse and cow manure for the fifth. Of these the manure seems to have been the most successful, probably because this is a prime food for the red wigglers (manure worms) we were using, and certainly "sweetened" the food waste. In our community there is a good demand for newspapers in the recycling business but there still remains a lot of paper at the school that is not recyclable, primarily paper towels and paper napkins. As we proceed, we plan to use these in the bins as bedding. In my experience the pulverized (by a hammermill) cardboard was difficult to handle dry and, when wet, tended to hold too much moisture. Cardboard, too, is a sought-after recyclable material.

**STEP FIVE:** Get the worms. Since we were still basically an unfunded project, with the exception of money from a can and bottle drive, we asked for donations of worms from those students who had bins at home. We also received a good quantity of worms, 30 pounds or more, along with some old silage given us by a generous farmer. The worms did fine over the summer with the little bit of food provided by school parents living nearby. The worm populations grew as predicted and, when school started, they and I were ready. The students were ready, too, as the food separation they had been doing the year before prepared them well for this new project.

**STEP SIX:** Begin the feeding. Some people advise putting only certain things in a worm bin and especially not putting in meat and cheese due to the possibility that it might attract rodents or create offensive odors. But knowing that the worms would



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eat it all, I decided to experiment and see how well they would do with the tacos, sub sandwiches and even the hamburgers.

Since the bins were located outside at the very edge of the school grounds, bad odors, if there were any, wouldn't be a problem, and if nocturnal critters made there way into the bins for midnight snacks well, I figured we'd deal with that problem if it happened. Along with the worm food we put in paper portion cups, paper napkins and straw wrappers for a while as an experiment. All were eventually turned into castings.

Each day the assigned monitors (2nd - 5th graders) helped to scrape the food waste off the trays, see that milk cartons were put in the recycle bin and that other items went into the trash bin. When lunch was finished, they weighed the food and then, rain or shine, we made the trek to the worm bins.

The students used garden forks to dig a trench the full length of the appropriate bin, poured in the food with appropriate comments like "Yuck!", "Gross!" etc. and covered it up. If it seemed a bit dry, after the buckets were rinsed out at the garden spigot, I'd add some water to the bin. Some school parents helped monitor this operation throughout the year, but I was there at least once a week to see that the worms were doing OK, and for my own education.

**STEP SEVEN:** Operation, maintenance and observations. As day after day passed, with anywhere from 15-30 lbs. of food waste (23.5 lbs. was the average for the first five months) being fed to these little red wigglers, a number of things became evident. Since we had five 4' x 8' bins and each bin had been theoretically divided into five areas to bury the food waste, there would be five weeks before we would have to bury it in a previously used spot. Although the worms were consuming the material (food and bedding), they weren't doing it as quickly as we had hoped and therefore food started to accumulate beyond the desired level. When that happened, it began to smell. Later the bins became too acidic, and when that happened, the worms began swarming to get away from the material. That was five months into the project and at that point I decided to stop feeding them and let them finish what was on their "plates." To neutralize the acidity I added a combination of powdered oyster shell, lime and wood ash. I also came once a week and turned the material in all of the bins with a pitchfork to introduce more air and to help the material dry out.

**STEP EIGHT:** Harvest the castings. Slowly but surely, from February to April, the worms did their magic and by Earth Day, April 18, we were ready to begin harvesting the castings. Thinking that our worm populations still needed to be larger for the job they had to do, there was no thought of selling excess worms at that time. To give a hands-on experience to as many students who wanted it, we did a "dump and sort" for half of one bin.



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Each classroom (K-5) came for about 20-30 minutes during the day to sort the worms from the castings, some eagerly, most carefully, and to shred newspaper to rebed the worms. It was a good Earth Day experience, but it was evident that dump and sort would not be the most effective way to empty the four-plus cubic yards of castings from the bins.

Since we had only emptied the front half of one bin, we were well set-up to try another recognized method of separating worms from castings -- migration.

When we started putting food on the newly bedded side, sure enough, the worms still on the castings side got the idea that "lunch was served," and within two weeks they had nearly all vacated the castings. Then it was an easy matter of shoveling out the castings and rebedding the emptied side of the bin.

The remaining bins were harvested in a similar manner, but instead of dump and sort, we took advantage of another habit of worms to harvest the first half of each bin. By leaving the plastic sheeting off the top of the material, it began to dry and, since there was now more light in the bins, the worms started heading for the bottom. As we removed castings from the top the worms continued to retreat downwards. Since the bottom layer was still fairly moist and needed further decomposition we mixed it along with the worms into the new bedding. Then, after introducing new food, we separated the second half of the bin by the migration technique described above.

All in all, thanks to a wonderful energetic bunch of students, over 2000 lbs. of food waste were put into the five worm bins in five months and, thanks to an equally energetic bunch of redworms, we were able to harvest over four cubic yards of castings. Some was put directly into the school garden with the spring planting, some was shared with Bev the night custodian (see sidebar) and the rest remains in piles near the garden to be used as needed.

During the summer, school parents who responded to an Adopt-a-worm-bin appeal have been feeding the worms to keep them in shape for this year's food waste recycling program. One thing that we are going to do differently this year is to put the food in by the layering method rather than burying it in trenches. In this method the food is spread out on top of the material already in the bin and covered with a layer of bedding. In theory this will introduce more air into the material (it's always good to promote aerobic bacteria) and it will also allow the worms to eat as they move upwards, which is their natural habit.

We also have five new bins without bottoms that are sitting directly on the ground. We planned to inoculate them with biofertilizer from a farm in Maryland that has begun composting food industry wastes using Uday Bhawalkar's Vermiculture Biotechnology method (see Worm Digest #7). But that's another story which we will report on when we see the results of that experiment.



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Looking over a year's worth of larger-scale vermicomposting at Walterville School, I'd give this project a B-. I learned a lot and hope to be able to do it better next year. With proper management it should be able to operate the full school year.

## WORM BIN CALCULATIONS

At Walterville School recorded food wastes ranged from 15 pounds to 30 pounds daily, depending on the menu and the weight of the items discarded. To be on the generous side we used the larger of the two figures, a move that we didn't regret. The calculations went like this: Since one square foot of worm bin is required for each weekly pound of food waste, 5 days x 30 pounds = 150 pounds or 150 square feet. A 4' x 8' bin has an area of 32 square feet, so five bins were needed. This gave us a 160 square foot area for food waste disposal. Since there is one bin for each day of the week, seven days pass between worm feedings in each bin. Ideally, with four-plus pounds of food to be eaten each day, 9-10 pounds of worms in each bin would suffice. However, since we did not purchase any worms, the total amount at any given time still remains just a guess.

## WORM CASTINGS! - A Testimonial

Although most of the worm castings are destined for the school's organic garden some do find their way into other gardens as well. Bev, the school's night custodian, traded the project a garden hose for a 32 lb. bucket of castings last March and by April was extolling the virtues of this gardener's gold. "Everything turned super green! I had already harvested my herbs once this season and now they have grown double in size again. My geraniums are now the size of rhododendron flowers. I had no idea my soil was so worn out. A rose bush I'd written off is now blooming and a jasmine that wasn't supposed to bloom until next year is blooming! All I need to do now is water! I'm really impressed! I'm starting a mini worm bin for myself!"

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# Appendices

## Appendix A: List of Educational Materials

### Curricula

*Closing The Loop,* California Integrated Waste Management Board, (916) 255-2385. K-12 curriculum contating reduce, reuse, recycle and compost activities.

*Compost! A Teacher's Guide To Activities & Resources In The East Bay,* Alameda County Home Composting Education Program, Oakland, CA, (510) 635-6275.

*Composting Across The Curriculum,* Marin County Office of Waste Management, San Rafael, CA, (415) 499-6647.

*Creepy Crawlies for Curious Kids,* Lynn Ransford (#217). Teacher Created Materials, Inc.: Sunset Beach, CA 1986.

*Critters,* AIMS Education Foundation (Grades K-6). AIMS Program Publications, Fresno Pacific College, P.O. Box 8120, Fresno, CA, 93747-8120.

*Critters in the Classroom,* Robert W. Smith (The Science Series, Grades 1-2 and Grades 3-4). Instructional Fair, Inc.: Grand Rapids, MI. (IF8504: Grades 1-2: IF8505: Grades 3-4).

*Earthworms: Nature's Recyclers,* J.Breckenridge (Grades K-6). Harmony Foundation: Ottawa, Ontario, Canada. 1992.

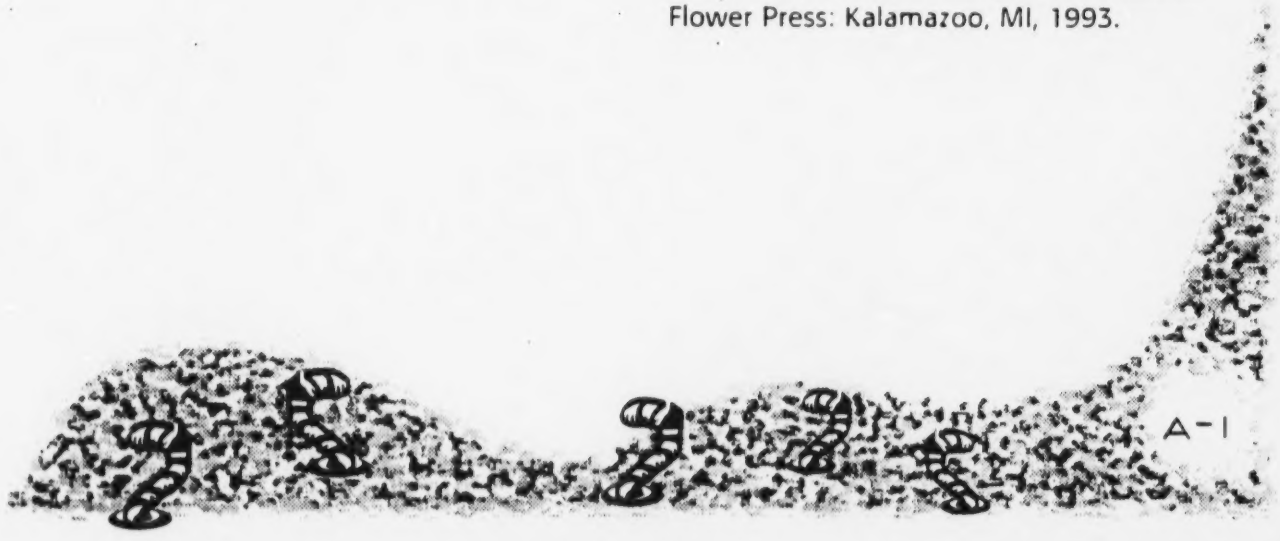
*Earthworms Teacher's Guide,* Robert Knott, Kimi Hosoume, and Lincoln Bergman, Grades 6-10. Great Explorations in Math & Science, Lawrence *Hall of Science,* University of California, Berkeley, 94720, 1989.

"Exploring the Structure of Earthworms," pp.23-26, *The Art & Science Connection: Hands-On Activities for Primary Students,* Kimberely Tolley. Addison-Wesley Publishing Co., 1993.

"Getting Hooked On Worms," pp. 214-221, *Grow Lab: Activities for Growing Minds.* National Gardening Association. 180 Flynn Avenue, Burlington, VT, 05401, 1990.

*The Wonderful World of Wigglers,* A Common Roots Guidebook, Julia Hand. Food Works: Montpelier, VT, 1995.

*Worms Eat Our Garbage,* Mary Appelhof, Mary Frances Fenton. Barbara Loss Harris. Flower Press: Kalamazoo, MI, 1993.



## Products Available From *The Worm Digest*

### *Worm Digest* Subscriptions

$12.00/year (4 issues)

Back Issues–$3.50 each
(SPECIAL: 5 for $14.00)

Bulk Quantities–50 @ $25, 100 @ $40, 200 @ $60, 500 @ $125

### Books

*Worms Eat My Garbage* by Mary Appelhof–$11.50

*Worms Eat Our Garbage: Classroom Activities for a Better Environment* by Mary Appelhof–$25.00

*Squirmy Wormy Composters* by Kalman & Schaub–$9.50

*Turning Garbage Into Gold* by Uday Bhawalkar–$15.00

*Vermiculture Ecotechnology* by Uday Bhawalkar (380 pages)–$150.00

*Annelida the Wonder Worm* by Katie B. Diepenbrock–$5.00

*Pee Wee and the Magical Compost Heap* by Larraine Roulston–$4.00

### Other Products

*The Art of Small-Scale Vermicomposting* (Pamphlet) by Worm Digest–$2.50

*The Art of Small-Scale Vermicomposting* by Worm Digest

- (12 Placards/Unlam.)-$33.00
- (12 Placards/Lam.)-$54.00
- Delivery–one week

*Turning Garbage Into Gold* (video) by Uday Bhawalkar (46 min.)–$28.00

*"Worm Farm"* Worm Bin (with instructions)-$40.00 + UPS Chgs. Delivery–one week

Worm Digest T-shirt (4-color/100% organic cotton/M,L,XL)-$20.00. Prices include postage and handling (except where noted). (541) 896-9058

**All items on this page are available** from the worm digest. Please make checks payable to ECRC and mail to:

Worm Digest
Box 544
Eugene, OR 97440

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# Appendix B: Worm Bin Ideas

## Small Plastic Worm Bin

Very easy to build; tidy for indoor use.

Plastic bins keep compost moist—will require regular additions of dry bedding

### Cost

$6–$20 for new materials

### Materials

Plastic storage container with a tight-fitting lid—min. 10" tall, 12"x 24" base

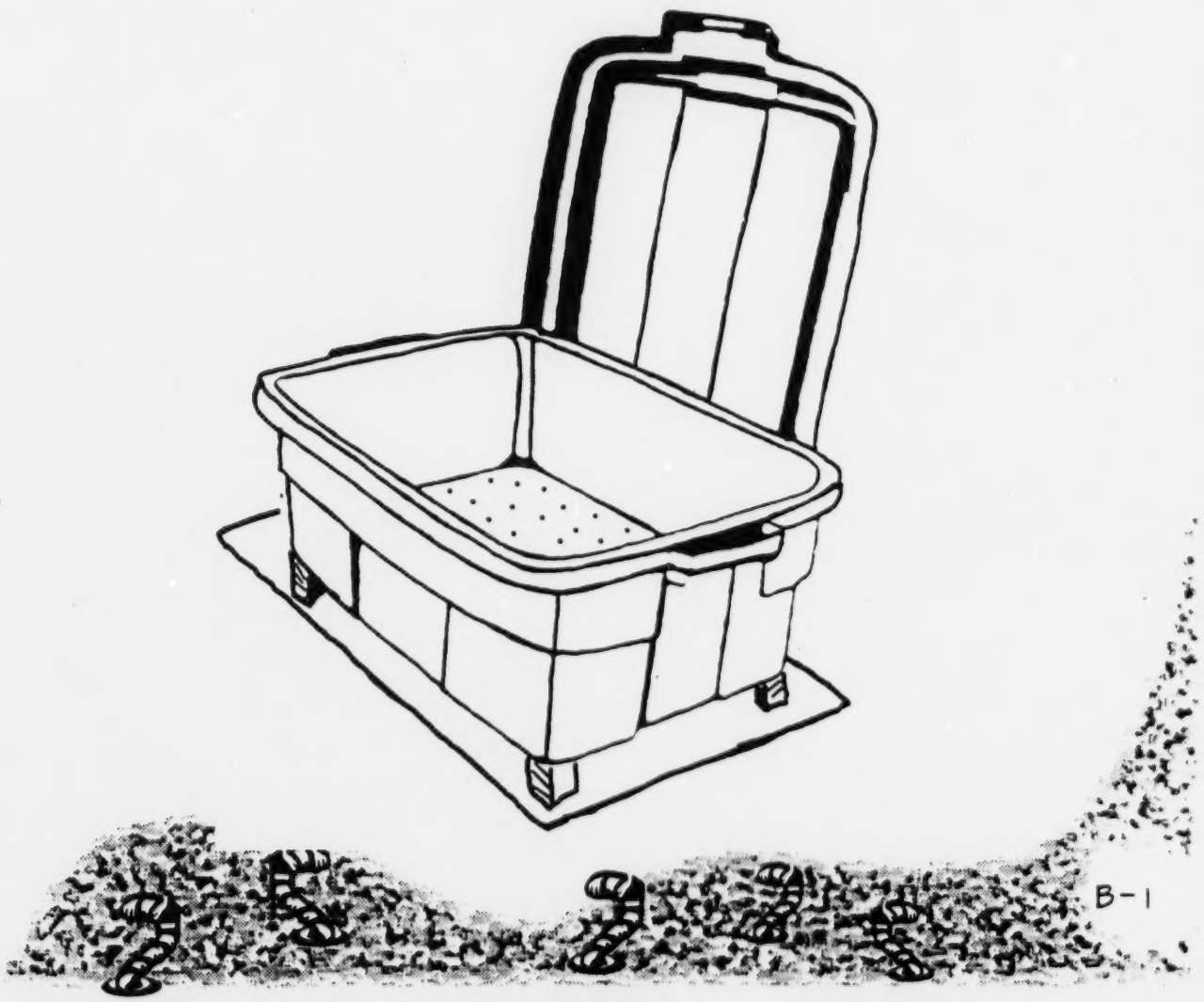
### Tools

Power drill with 1/4" bit.

### Assembly

Holes can be drilled in the bottom for ventilation and drainage. Use 1/4" drill bit to make holes about 1" apart.

Place blocks under the worm bin to allow air to circulate and the liquid to drain. Use scrap wood, plastic soda bottle caps, or empty yogurt containers. Adhere the blocks to the bin using screws, nails or glue. To collect any liquid, place a plastic tray or newspaper underneath the bin.



# WES students dig their new disposal system

By AMY GITTEI SOHN
Trinity Journal Reporter

[illegible] loving worms is a good thing

[illegible] worms that is. At Weaverville Elementary School they eat office hard and used paper, turning it into a rich soil amendment. The worms have hearty appetites too, and are able to eat half their body weight each day.

[illegible] of the packet performed one young worm took her during a recent visit to the worm project at the school.

[illegible] Odell and Sue Cousins are participating in the project.

We call the red worms stuff that they can eat in the garbage [illegible] explained Devon Lethbridge, a third grade student. The project began on a small scale but has grown to the point that 75 percent of the cafeteria waste is thrown to the worms. Odell said.

Last year Odell received about red worms at a worm booth during Earth Day, and the county solid waste department has encouraged vermiculture. The original batch of worms was purchased with $75 and in the Sculptured Garden with students' designs of worm beds made from tires. Area corporate workers made the beds with used tires from the dump.

WES's worm beds have caught the attention of "Worm Digest" in Oregon. The editor has asked for an article on the project.

[illegible] been a real undertaking," Odell said. "I don't think we could have gotten so big so quick."

About 10 pounds of food a day is given to the worms. They are fed fruit and vegetable products, although Odell noted that dairy products [illegible] properly preparation.

Every day with the help of volunteer Sue Lethbridge (the third-grade student [illegible] separate the worm food from dairy and meat products. Helpers bring the food in and weigh it before putting it in the bins. They also measure the temperature in the bins to make sure it is not too hot or cold.

The idea is that students not only learn a lot about worms, but also about how much they throw out. "We wanted the kids to be aware of the amount of waste we go through and try to cut down," Odell said.

The concept of vermiculture goes beyond merely composting material to [illegible] plus the added benefit of worm castings (feces) [illegible] called "black gold." The castings have been [illegible] with at the Farmer's Market. Proceeds will be [illegible] more worms, which cost $10 to $15 per pound.

"Our aim is to recycle 100 percent of the cafeteria waste," Odell said. Bake sales have also been held to increase the [illegible]. "We do anything for worms," Odell said.

Eventually, Odell hopes there will be students to take on other small-scale vermiculture. Small worm boxes can be kept under sinks, like a living garbage can. Odell and Cousins keep actual worm bins in their classrooms.

Summer could provide an opportunity for some people to learn more about vermiculture. With the student labor about to take off, volunteers will be needed to take care of the worms.

Students from Mrs. Odell's class peer into one of the worm beds made of used tires from the dump. *(Photos by Phil Nelson)*

Dana Morelli, a student in Sue Cousins' fourth grade class, holds a handful of the red wigglers used to reduce the school's waste.

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# Appendix C: Worm Suppliers

Note: Visit the CIWMB Web-site at www.ciwmb.ca.gov/mrt/wpw/wporgnc/wrm/list1.htm for the most current version of the worm suppliers listing.

### Known Worm Suppliers In California

Vermicomposting is becoming a popular Waste Prevention activity in California. In order to assist those who may wish to become involved in this beneficial activity, the California Integrated Waste Management Board (CIWMB) staff has compiled a list of known worm suppliers in California. The inclusion of companies in this list does not constitute an endorsement by the CIWMB nor does the absence of a company constitute a criticism. Companies are included upon request. The following is the list of known worm suppliers in California as of August 1997:

One Enterprises, Int'l
Alta Loma
Marcia Iannone
(909) 987-2979
mliannone@csupomona.edu

Redwood Valley Worm Farm
Blue Lake
Tim & Peggy Matthews
(707) 668-5997 (May to Nov.)

Vermicoast
Carlsbad
Shelley Grossman
Toby Weitzel
(619) 434-4223
vermicoast@aol.com

Bond Worm Farm, Inc.
Ceres
Wanda Bond
(209) 537-2423

Rainbow Worm Farm
Davis
Al Cardoza
(916) 758-9906
104066.2773@compuserve.com

Morning Mist Worm Farm
Dixon
Jim and Karen Cain
(707) 448-6836
mmcain@community.net

Fox Farm, Soil & Fertilizer Co.
Eureka, Trinidad
Willie Winer
(707) 441-1991 or 677-1991

Jake Worm Farms
Fortuna
Andrew Jolin
(707) 725-6966

WormCo
Lincoln
Calvin Sierer
(916) 645-9419

Avant Garden Vermicomposting
Point Reyes Station
Loretta Neumann
(415) 663-1975

Cal Poly Pamona Landlab
Pomona
Marcia Iannone
(909) 869-4449
mliannone@csupomona.edu

Yahoo Herb'an Ecology
San Francisco
Fernando Pastor
(415) 282-WORM (9676)
yahoo@igc.org

Ecoway
Santa Ynez
Myriam & Mitchell Goldberg
(800) 770-7778
ecoway@aol.com

Sonoma Valley Worm Farms
Sonoma
Jack Chambers
(707) 996-8561
(800) 447-6996

Happy D Ranch Worm Farm
Visalia
Glenn & Jill Dembroff
(209) 627-8807
hppydworms@aol.com

# Appendix D: Worm Bin Suppliers

Note: Visit the CIWMB website at www.ciwmb.ca.gov/mrt/wpw/wporgnc/wrm/list1.htm for the most current version of the worm bin suppliers listing.

### Known Worm Box Suppliers In California

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Alta Loma
Marcia Iannone
(909) 987-2979
mliannone@csupomona.edu

Redwood Valley Worm Farm
Blue Lake
Tim & Peggy Matthews
(707) 668-5997

Rainbow Worm Farm
Davis
Al Cardoza
(916) 758-9906
104066.2773@compuserve.com

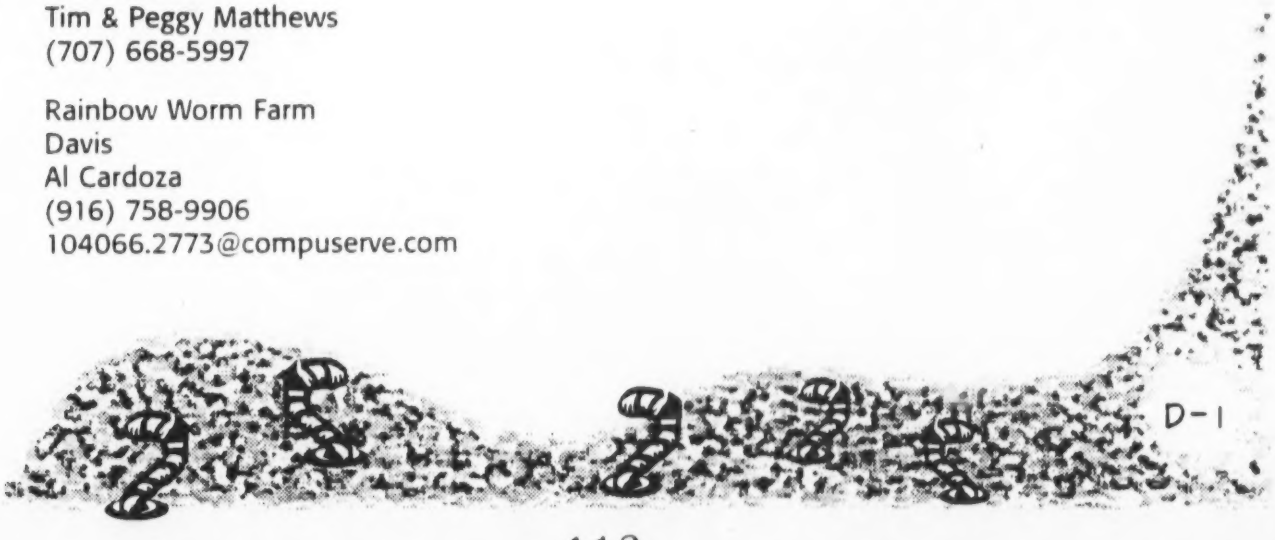
Ecoway
Santa Ynez
Myriam & Mitchell Goldberg
(800) 770-7778
ecoway@aol.com

Avant Garden
Point Reyes Station
Loretta Neumann
(415) 663-1975

Yahoo Herb 'an Ecology
San Francisco
Fernando Pastor
(415) 282-WORM (9676)
yahoo@igc.org

The Happy D Ranch Worm Farm
Visalia
Glenn & Jill Dembroff
(209) 627-8807
hppydworms@aol.com

Superior Composting Systems
Sonoma
Mary Wilcox , George Weiss, Jr.
(707) 935-3826
scs@vom.com



# Worm and Worm Box Suppliers in California

Compiled by the California Integrated Waste Management Board

The inclusion of companies in these lists does not constitute an endorsement by the CIWMB nor does the absence of a company constitute a criticism. Companies are included upon request.

This data is maintained by Ken Decio. Additions and questions can be sent to him at kdecio@ciwmb.ca.gov These lists were updated on October 5, 1998.

Worm Suppliers | Worm Box Suppliers | For more info

## Known Worm Suppliers

| Location | Suppliers |
|---|---|
| Aguanga | **Worms-R-Us**<br>Bill Williams<br>(909) 767-7678 or (760) 782-0469 |
| Alpine | **Alpine Worm Farm**<br>Belora Bryant<br>(619) 445-4604<br>bab@znet.com |
| Alta Loma | **Iannone Enterprises, Int'l**<br>Marcia Iannone<br>(909) 987-2979<br>miannone@earthlink.net |
| Anaheim Hills | **The Wright Worm Farm**<br>Don and Bobbi Wright<br>(714) 921-9047<br>wriwormf@Pacbell.net |
| Applegate | **Worms By Wiemar**<br>Jules Duval<br>(916) 878-7757 |
| | **Redwood Valley Worm Farm** |



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|---|---|
| **Blue Lake** | Tim & Peggy Matthews<br>(707) 668-5997 (May to Nov.) |
| **Carlsbad** | **Vermicoast**<br>Shelley Grossman and Toby Weitzel<br>(760) 439-4737<br>vermicoast@aol.com<br><br>**The Worm Wrangler**<br>Paul Vanvooren<br>(619) 729-7227 |
| **Cathedral City** | **Down To Earth Worms**<br>Judy Reeder<br>(760) 327-8757<br>jworms@wwwinwin.com |
| **Ceres** | **Bond Worm Farm, Inc.**<br>Wanda Bond<br>(209) 537-2423 |
| **Coarsegold** | **Foley Farms**<br>Pat Foley<br>(209)642-6264<br>foleys@sierratel.com |
| **Davis** | **Rainbow Worm Farm**<br>Dan or Dru Cardoza<br>(530) 758-9906<br>rwf@ates.com |
| **Dixon** | **Morning Mist Worm Farm**<br>Jim and Karen Cain<br>(707) 448-6836<br>mmcain@community.net |
| **Eureka, Trinidad** | **Fox Farm, Soil & Fertilizer Co.**<br>Willie Winer<br>(707) 441-1991 or 677-1991 |
| **Eureka** | **Northcoast Vermicyclers**<br>Dennis J. Estes<br>(707) 441-1052<br>destes@humboldt1.com |
| **Fontana** | **Biorecycling Technologies, Inc.**<br>Tom D. Wilson<br>(909) 899-2982 |
| **Foresthill** | **Shallow Creek Ranch**<br>Steve Smith<br>(530) 367-3174<br>SCS@Foothill.net |
| **Fortuna** | **Jake Worm Farms**<br>Andrew Jolin |



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| | |
|---|---|
| **Fortuna** | (707) 725-6966 |
| **Fremont** | **Pacific Industries**<br>Rich Watson<br>(510) 795-0760<br>pacificind@earthlink.net |
| **Grass Valley** | **Cedar Ridge Worm Farm**<br>Michael and Nancy Ray<br>(530) 273-4418<br><br>**Wally's Worm Ranch**<br>Mary Lee Allen<br>(530) 265-6104<br>mlallen@jps.net |
| **Galt** | **Anderson Worms Unlimited**<br>Tim Anderson<br>(209) 745-2576<br>Candy@lodinet.com |
| **Lincoln** | **WormCo**<br>Calvin Sierer<br>(916) 645-9419 |
| **Littlerock** | **Oasis Worm Farm**<br>Norma Minto<br>(805) 944-6199 |
| **Kelseyville** | **Lake County Worm Farm**<br>Richard Morhar<br>(707) 279-8032<br>(800) 399-9464 |
| **Malibu** | **Whizzy Worms**<br>Lorna D. Crafton<br>310) 457-3143<br>Lorna.Crafton@GTE.net |
| **Newcastle** | **Avalon Farms**<br>Steve Salazar<br>(800) 808-3136<br>Salazar@Rejobi.com |
| **North Fork** | **Magnus Enterprises, Inc.**<br>George Schroder<br>(209) 877-4862<br>(209) 877-3019<br>rv@sierranet.net |
| **Nuevo** | **Broads Worm Farm**<br>909-926-9076<br>broad@lasercom.net |
| | **Blue Belly Farm** |



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| | |
|---|---|
| **Penn Valley** | Todd Spratt<br>530-432-8267<br>TEATSS@JPS.NET |
| **Placerville** | **Sierra Elementary School**<br>Jack Brabrook or Ms. Boolootian<br>(530) 622-0814 |
| **Point Reyes Station** | **Avant Garden Vermicomposting**<br>Loretta Neumann<br>(415) 663-1975 |
| **Potter Valley** | **Willie Worms**<br>Bill Courtney<br>(707) 468-9874 |
| **Ramona** | **Sharon's Worm World**<br>Sharon McLachlan<br>(619) 788-4423 |
| **Rancho Cordova** | **Worm Bins To Go**<br>Andrea Walker<br>(916) 631-7701<br>AhnieW@aol.com |
| **Ridgecrest** | **Valley Worm Growers**<br>John Banks<br>(760) 371-1160<br><br>**Wonder Worms**<br>John & Bonnie Mathis<br>(760) 371-1129<br>jbmathis@ridgecrest.ca.us |
| **Riverside** | **Biological Home Grown Farms**<br>Tom Bennington<br>(909) 681-8256 |
| **San Francisco** | **Yahoo Herb 'an Ecology**<br>Fernando Pastor<br>(415) 282-WORM (9676)<br>yahoo@igc.org |
| **San Jacinto** | **VanArsdale's Worm Sales**<br>Frank VanArsdale<br>(909) 487-9269<br>wormguy@ivic.net |
| **San Jose** | **Ken's Bait & Tackle**<br>(408) 371-0370<br><br>**Worm Works**<br>Ladonna Kaneshiro<br>(408) 248-6442<br>Lkaneshiro@worldnet.att.net |



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| | |
|---|---|
| **Santa Cruz** | **The Skills Center Worm Farm**<br>(831) 476-6501, ext. 110 |
| **Santa Ynez** | **Ecoway**<br>Myriam & Mitchell Goldberg<br>(800) 770-7778<br>ecoway@aol.com |
| **Sonoma** | **Mother's Earth Worms**<br>Cinder Brown<br>(209)928-3350<br><br>**Sonoma Valley Worm Farms**<br>Jack Chambers<br>(707) 996-8561 or (800) 447-6996 |
| **Thousand Oaks** | **The Worm Connection**<br>Timothy Morhar<br>(805) 376-9918 |
| **Visalia** | **Bassetts Cricket Ranch, Inc.**<br>Russell Bassett<br>(209) 747-2738<br><br>**The Happy D Ranch Worm Farm**<br>Glenn & Jill Dembroff<br>(209) 738-9301<br>glenn@happydranch.com |

## Known Worm Box Suppliers

| Suppliers | Products |
|---|---|
| Iannone Enterprises, Int'l<br>**Alta Loma**<br>Marcia Iannone<br>(909) 987-2979<br>miannone@earthlink.net | High-tech worm bed box: Large-scale worm composting bin with three chambers (12' x 2.5' x 16" high). Stands on 20" legs. It has three sections w/removable center and end panels. Each section has a pull-out drawer below the bed. Price for plans: $50.00. |
| Rainbow Worm Farm<br>**Davis**<br>Dan or Dru Cardoza<br>(530) 758-9906<br>rwf@afes.com | "The Little Worm Farm" (20" x 13.5" x 8" high). Includes: worms, a light, a water bottle, bedding mix, oyster flour, worm gro (food), a piece of carpet for cover, and instructions. Price: $59.95 + shipping and tax. |
| Northcoast Vermicyclers<br>**Eureka**<br>Dennis J. Estes<br>707 441 1052<br>destes@humboldt1.com | Can-O-Worms TM.: 100% postconsumer plastic bin with spigot (20"diameter x 29" high). System has three stacking trays, a base, and a lid. Worms self separate from castings. Price: $119.95+ shipping and tax. |
| Squiggly Ranch | Wriggly Wranch Vermicomposting System: Sold wholesale |


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|---|---|
| **Los Angeles**<br>Denise Epport<br>888-469-6767<br>dkepport@aol.com | only to government entities and refuse companies. Increase your organics diversion rates with this self-harvesting worm bin. Custom distribution programs are available. Price: $59 + freight & tax or less in larger quantities. |
| **Avalon Farms**<br>**Newcastle**<br>Steve Salazar<br>(800) 808-3136<br>SSalazar@Rejobi.com | BioMate PC: The system is "prestarted" and comes complete with bedding, bed cover, hand tool, information package, support line, and worms. Capacity: 8 gallons. Price: $48.00 plus shipping and applicable CA sales tax.<br><br>The Villager BioBin: This system is "prestarted" and comes complete with bedding, bed cover, hand tool, information package, support line, and worms. Capacity: 33 gallons. Price: $88.00 plus shipping and applicable CA sales tax. |
| Magnus Enterprises, Inc.<br>**North Fork**<br>George Schroder<br>(209) 877-4862<br>rv@sierranet.net | Magnus Wormworks: includes lid and starter bedding. Worms Extra. Price: $125.00 plus shipping and applicable CA sales tax. |
| Blue Belly Farm<br>**Penn Valley**<br>Todd Spratt<br>530-432-8267<br>TEATSS@JPS.NET | |
| Avant Garden<br>**Point Reyes Station**<br>Loretta Neumann<br>(415) 663-1975 | The Avant Garden Vermicomposting System: Plastic worm bin that comes with a spigot (27"x17"x13"high). Light grey color with six large, side air vents. Indoor or outdoor use. Price: $68.00–Shipping. Also sold at Natural Gardening Co. in San Anselmo, (415) 456-5060. |
| Goldenrod Products<br>**Redding**<br>Judith A. Staley<br>(530) 365-7013 | 1. Small plastic drawer type, that sits nicely on a shelf for $24.95 plus S&H includes worms, bedding, instructions.<br>2. Larger plastic drawer type, that fits nicely on counter, undersink, etc., includes worms, bedding, instructions and **free** enrollment in Vermy Village School House (6 week course on vermicomposting from A-Z) for $39.95<br>3. A large 4'x4'x4' Stainless Steel Kit that separates the castings from the castings quickly, easily and efficiently. Doesn't have any mechanical parts to break down. For a limited time $1,249.00 plus S&H includes worms, full instructions and consultation. |
| Yahoo Herb 'an Ecology<br>**San Francisco**<br>Fernando Pastor<br>(415) 282-WORM (9676)<br>yahoo@igc.org | All bins include information, bedding, and 2 lbs of worms. Small is 18" x 30" x 14" high, 100% recycled wood. Price: $40.00. Large is 2' x 3' x 14" high, 100% recycled plywood Price: $50.00. Coming soon: 1.5' x 2.5' x 18" high, 100% recycled plastic. Price: $45.00. |
| The Skills Center Worm Farm<br>**Santa Cruz**<br>(831) 476-6501, ext. 110. | Can-O-Worms TM.: 100% postconsumerplastic bin with spigot (20"diameter x 29" high). System has four trays that stack with castings being left in lower trays and 1 lb. of worms. Price: $85.00+ shipping and tax. |

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|---|---|
| **Ecoway**<br>**Santa Ynez**<br>Myriam & Mitchell Goldberg<br>(800) 770-7778<br>ecoway@aol.com | Can-O-Worms TM.: 100% postconsumer plastic bin with spigot (20" diameter x 29" high). System has four trays that stack with castings being left in lower trays and 1 lb. of worms. Price: $90- shipping and tax. |
| Superior Composting Systems<br>**Sonoma**<br>Mary Wilcox, George Weiss, Jr.<br>(707) 935-3826<br>scs@vom.com | Can-O-Worms TM.: 100% postconsumer plastic bin with spigot (20" diameter x 29" high). System has three stacking trays, a base, and a lid. Worms self-separate from castings. Price: $119.95+shipping and tax. |
| **The Happy D Ranch Worm Farm**<br>**Visalia**<br>Glenn & Jill Dembroff<br>(209) 738-9301<br>glenn@happydranch.com | Can-O-Worms TM.: 100% postconsumer plastic bin with spigot (20" diameter x 29" high). System has three stacking trays, a base, and a lid. Worms self-separate from castings. Price: $89 plus shipping and applicable CA sales tax. |

## For more information:

This data is maintained by Ken Decio. Additions and questions can be sent to him at kdecio@ciwmb.ca.gov

California Integrated Waste Management Board
Waste Prevention Info Exchange
(916) 255-INFO
wpinfoex@ciwmb.ca.gov

Last updated: October 5, 1998
http://www.ciwmb.ca.gov/mrt/wpw/wporgnc/wrmlist1.htm



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